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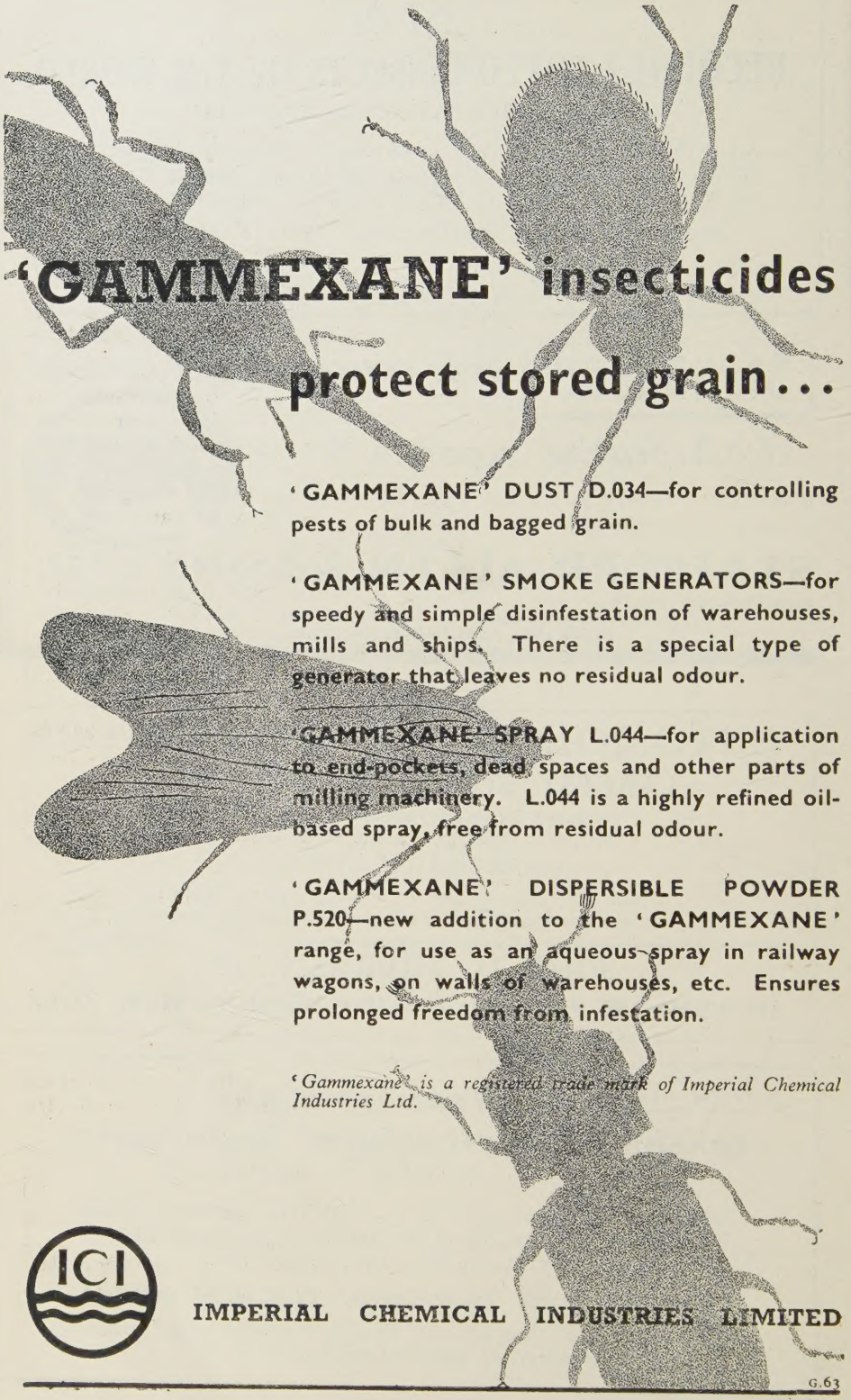

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SMITH (K. M.). **Tomato Black-ring : a New Virus Disease.**—*Parasitology* **37** no. 3–4 pp. 126–130, 2 pls., 10 refs. London, 1946.

A new virus causing a disease in tomato, for which the name tomato black-ring is proposed, was recovered from a tomato fruit in England in 1944. Its properties and the symptoms produced in tomato and other plants are described. It was readily transmitted by sap-inoculation to plants of 14 families, but all did not develop symptoms. Transmission tests with *Myzus persicae*, Sulz., and *Macrosiphum solani*, Kalt. (*Myzus convolvuli*, Kalt.) gave negative results. The distinguishing characters of this virus and seven others, all of which have certain characters in common, are given. All have similar physical properties and cause ringspot on tobacco, and plants infected by all of them show rapid powers of recovery. Many have been observed only once, generally on isolated plants, and none is known to be transmitted by insects.

SMITH (K. M.). **The Transmission of a Plant Virus Complex by Aphides.**—*Parasitology* **37** no. 3–4 pp. 131–134, 4 refs. London, 1946.

Some of the information in this account of experiments on the transmission by Aphids of the rosette disease of tobacco have been noticed from a preliminary note [*R.A.E.*, A **34** 70]. The following is based on the author's summary. The component viruses (the vein-distorting virus and the mottle virus [*cf.* also **36** 422]) persist for long periods in the body of the Aphid vector, and as many as 20 consecutive tobacco plants can be infected in daily serial transfers without the insect having recourse to a fresh source of virus. Of four Aphids tested in transmission experiments, *Myzus persicae*, Sulz., was a more effective vector of both the vein-distorting virus and the complex than *Macrosiphum solani*, Kalt. (*Myzus convolvuli*, Kalt., *pseudosolani*, Theo.). *Myzus circumflexus*, Buckt., and *Macrosiphum solanifolii*, Ashm. (*gei*, auct.) failed to transmit them [*cf.* **36** 422]. The mottle virus could not be transmitted by Aphids from plants that did not also harbour the vein-distorting virus, even though the latter was present in the Aphid or other Aphid-transmitted viruses in the plant. Neither did the presence of the vein-distorting virus in the plant enable other viruses that are not normally transmitted by Aphids to be picked up by them.

RAUCOURT (M.) & BOUCHET (R. L.). **Un nouvel insecticide organique de synthèse : l'hexachlorocyclohexane.**—*Chim. & Industr.* **56** pp. 449–455, 29 refs. Paris, 1946.

The authors describe the discovery in England and France of the insecticidal properties of benzene hexachloride [*cf. R.A.E.*, A **33** 256, 331], discuss the properties of its isomers and its modes of action, give short notes on its effectiveness against a number of insect pests of plants, mainly in France, state that it has caused no injury to the many kinds of plants on which they have used it, and refer to experiments indicating that its toxicity to mammals is negligible.

PETTY (B. K.). **Laboratory Apparatus and Technique for the Evaluation of the Toxicity and Adhesiveness of Insecticides.**—*Sci. Bull. Dep. Agric. S. Afr.* no. 267, 15 pp., 6 figs., 2 refs. Pretoria, 1946.

In the first part of this paper, the author describes an apparatus for testing insecticidal dusts in a bell-jar that has been developed from one briefly described in 1932 [*cf. R.A.E.*, A **21** 35]. The bell-jar stands on a rubber mat, and the dust is blown through four vertical tubes projecting upwards from a small container suspended in it. The dose applied is regulated by weighing a glass plate 28 sq. cm. in area before and after a previous application. Dosages

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accurate to 0·1 mg. on this plate can be obtained. Methods of using the apparatus for testing stomach and contact insecticides and for determining residual effect are discussed.

In the second part, a simple laboratory apparatus for the quick and accurate application of contact sprays, and the method of using it, are described. The spraying is done in a cylindrical tower, and the apparatus can be adjusted to give any rate required by varying the amount of spray liquid in the reservoir and the spraying pressure.

The third part contains a description of an apparatus for testing the adhesiveness of insecticidal dusts on foliage, in which leaves dusted in the bell-jar are subjected to a controlled amount of vibration, and the quantities of dust knocked off and remaining on the foliage are determined.

PETTY (B. K.). **Miscellaneous D.D.T. Studies, with special Reference to some common agricultural Pests.**—*Sci. Bull. Dep. Agric. S. Afr.* no. 276, [1+] 16 pp., 13 refs. Pretoria, 1946.

The results are given of laboratory tests of DDT and other insecticides against insect pests of importance in South Africa, together with those of a few preliminary field experiments. In most tests, the materials were applied as dusts to both pest and foliage in a bell-jar apparatus [see preceding abstract]. The mortality percentages are calculated according to Abbott's formula [*R.A.E.*, A **13** 331]. A dust of 5 per cent. BHC (benzene hexachloride containing 10 per cent. γ isomer) gave complete mortality of adults of the Pentatomid, *Bagrada hilaris*, Burm., in 48 hours at a rate equivalent to 10 lb. per acre, whereas a 5 per cent. DDT dust gave only 90 per cent. mortality in 96 hours when applied at the same rate and in 72 hours at double the rate; bugs dusted with 5 per cent. pyrethrum all recovered in two hours. A spray containing 0·2 per cent. DDT as an emulsified solution appeared to be more effective than the dust. Preliminary field tests on cabbage indicated that the BHC and DDT dusts give satisfactory control at 15 lb. per acre. In tests with *Laphygma exempta*, Wlk., in which the dusts were applied at 15 lb. per acre, undiluted natural cryolite and 5 and 10 per cent. DDT gave 100, 98·9 and 100 per cent. mortality of third-instar larvae, respectively. Cryolite and 5 per cent. DDT gave 94 and 97·5 per cent. mortality, respectively, of fourth-instar larvae, but whereas cryolite killed 88·9 and 91·3 per cent. of the larvae in the fifth and sixth instars, 5 per cent. DDT killed only 65·5 and 35·2 per cent., and the 10 per cent. DDT only 64·2 and 48·2 per cent. BHC was markedly inferior to both DDT and cryolite. Cryolite appeared to exert most repellent action. In field tests by W. J. van de Linde, DDT dust at 30 lb. per acre was effective only against larvae in the first four instars.

Acanthopsyche junodi, Heyl., on wattle [*Acacia*] has best been controlled by cryolite applied from an aeroplane [**28** 191], but heavy applications are necessary, owing to the repellent action of the cryolite, and rain falling within 24 hours considerably reduces its efficacy. In laboratory tests in 1944, undiluted natural cryolite was about as effective as a mixture of cryolite and DDT (9 : 1), and much more effective than 5, 10 or 20 per cent. DDT in an inert carrier. In 1945, 5 per cent. BHC gave 80–93·3 per cent. mortality, cryolite 50–70 per cent., and 5 per cent. DDT 25–32·4 per cent. Dusts of pyrethrum and DDT, both in talc, were tested against the Jassid, *Bythoscopus cedaranus*, Naudé, and the Mirid, *Lygidolon laevigatum*, Reut., which cause "froghopper" damage to wattle. When applied to the adults [*cf.* **29** 278] in the absence of leaves at a rate equivalent to 15 lb. per acre, 2 per cent. pyrethrum gave 90·8–100 per cent. mortality of *Bythoscopus* and 82·3–100 per cent. of *Lygidolon*, whereas the corresponding figures for 5 per cent. DDT were only 50–67·8 and 56·2–65·4. As the nymphs of both species are known to be more susceptible to

pyrethrum than the adults and measures against the nymphs afford the best protection, their susceptibility to DDT was tested. Nymphs of *Bythoscopus* proved about as susceptible as the adults to a 5 per cent. dust, but the percentage mortality among nymphs of *Lygidolon* was 80–96, as compared with 64·5–81·5 for adults. When the dust was applied to the foliage as well as to the insects, the percentage kills of nymphs and adults of *Bythoscopus* increased from 67·4 and 65·6 to 88·7 and 86·2, respectively, and that of nymphs and adults of *Lygidolon* from 88·6 and 69·4 to 100 and 86·7.

Dusts containing 4 per cent. DDT or BHC were highly toxic to soldiers and workers of *Eutermes* (*Trinervitermes*) *havilandi*, Fuller [*cf.* **23** 377] in the laboratory, but were unsatisfactory in the field, owing to the difficulty of obtaining adequate penetration throughout the nests ; both insecticides were strongly repellent to the termites. One application of a spray containing 2 per cent. DDT as an emulsified solution gave good control of cochineal [*Dactylopius opuntiae*, Ckll.] on spineless cactus [*Opuntia*] in experimental plots, and eight weeks later infestation on plants that received it was markedly less than on untreated ones. The spray did not injure the plants and is considered to be the most promising treatment yet tested against this Coccid. Dusts containing 3 and 5 per cent. DDT applied at approximately 7½ lb. per acre caused almost twice as much mortality of larvae of *Plutella maculipennis*, Curt., as undiluted natural cryolite, and a 5 per cent. DDT dust applied at 15 lb. per acre against *Gonipterus scutellatus*, Gylh., killed 95 per cent. of the adults, whereas cryolite killed only 25 per cent. and BHC and calcium arsenate were still less effective. DDT applied at 1 per cent. as a soil insecticide against larvae of *Sciobius granosus*, Fhs., was ineffective ; complete mortality was given by inter-still residue, polymethyl naphthalene and pentachlorphenol at 0·36 per cent.

In experiments on the persistence of toxic residues from sprays of 5 per cent. DDT in kerosene (3·5 per cent. p,p′DDT) on different surfaces commonly used in household construction in which workers of *E. havilandi* were used as test insects, it was found that the period for which the deposit remained effective varied with the nature of the treated surface ; glass proved the most satisfactory, mortality remaining complete for two months. Surfaces painted with flat, enamel and oil paints, an oil varnish and an oil stain were unsatisfactory when the spray was applied as long as a month after the surfaces were painted. Wood that had been painted with oil paint several years previously gave considerably better results than freshly painted surfaces, but the toxic effect mostly disappeared in a month. Similar tests to prove whether sprays containing pure DDT have a longer residual action than those made up with impure DDT but containing the same amount of p,p′isomer showed the reverse to be true. When DDT, its o,p′isomer and eleven analogues and related compounds, including DDD (p-dichlordiphenyldichlorethane) and two of its analogues, were applied as 10 per cent. dusts to the termites, only αα-bis(p-methyl-phenyl)-ββ-dichlorethane approached DDT in toxicity.

MICHELBACHER (A. E.), MIDDLEKAUFF (W. W.), FRENCH (O. C.) & PARKER (W. B.). **Control of Dust Drift.**—*Agric. Chem.* **2** no. 3 pp. 21–23, 52–54, 68, 1 fig. New York, N.Y., 1947.

Poisoning of bees and livestock by drifting dust insecticides has become a major problem in California, and investigations were carried out in 1946 to find poisons suitable for the control of pests of tomato that would not cause the drift damage generally resulting from those now used in the northern part of the State, where large quantities of calcium arsenate have drifted to pollen and nectar plants, lucerne fields and pasture land round tomato fields.

The most important pests that attack tomato during the summer and autumn in northern California are the tomato mite [? *Vasates destructor*, Keifer], tomato fruitworm [*Heliothis armigera*, Hb.], hornworms [*Protoparce*], beet armyworm [*Laphygma exigua*, Hb.], western yellow striped armyworm [*Prodenia praefica*, Grote], tomato pinworm [*Gnorimoschema lycopersicella*, Busck] and potato tuber moth [*G. operculella*, Zell.]. The mite is controlled by sulphur and for adequate protection from the insects it is usual to make three applications of dusts containing calcium arsenate, in early July and early and late August, and sometimes a fourth if small developing tomatos are infested by young larvae of *Heliothis*. The danger of damage to bees and livestock can be reduced by substituting cryolite for calcium arsenate in some localities, by applying calcium arsenate only under the most favourable weather conditions and if it is necessary to protect the crop, and by delaying dusting until after adjacent lucerne hay crops have been harvested or adjacent pastures thoroughly grazed. The best available equipment should be used ; tractor-mounted row crop dusters are more desirable than aeroplanes, but the use of ground machines is no guarantee against dust drifting.

In the tests made in 1946, the use of hoods on the dusting machines failed to reduce drift, even under favourable weather conditions, and although the incorporation of 2 or 4 per cent. highly refined oil in calcium-arsenate dust tended to prevent it from rising, it did not cause it to settle ; the dust cloud remained near the ground, but still drifted from the field being treated. A concentrated spray of 12 lb. commercial calcium arsenate, 1 U.S. gal. oil emulsion and 3 U.S. gals. water gave good control with no drift when applied with a compressed-air atomising power sprayer. When it was applied by aeroplane, no serious drift occurred, but the lack of precision shutoff valves at the nozzles made it impossible to confine the application to the field being treated, and the atomising device could not be regulated accurately as to rate of delivery or particle size. Many of the particles were too large and injured very young fruits, but this had no apparent adverse effect on the yield. The spray was applied by aeroplane at $5\frac{1}{4}$, $7\frac{1}{2}$ and 10 U.S. gals. per acre on 7th and 28th August to a field that had been dusted with calcium arsenate and sulphur (3 : 7) on 20th July. All the treatments gave fair control, which was comparable with that from the regular calcium-arsenate programme. It is concluded that the spray shows promise, and methods of applying it are being improved.

To determine the effectiveness of some of the newer insecticides and several calcium-arsenate mixtures against the caterpillars, plots that had been dusted with a mixture of commercial calcium arsenate and sulphur (3 : 1) on 13th July were treated on 1st and 23rd August with dusts of 3 or 5 per cent. DDT, 5 per cent. DDD (dichlordiphenyldichlorethane) or commercial calcium arsenate alone or with 2 per cent. oil, or with the concentrated spray. All treatments resulted in good and lasting control, though all but the DDD plots showed an increase in the percentage of infested fruit on 28th October, and this was most marked in the case of 3 per cent. DDT. The two most important caterpillars attacking the tomatos were *Laphygma* and *Heliothis*. Counts of infested fruits showed that DDT and DDD gave slightly better control than the commercial calcium arsenate treatments, and that the spray was at least as effective as the calcium-arsenate dust. Rather large populations of the tomato mite developed in the sprayed plot, but so late in the season that little or no damage to the crop could be detected. The effect of the treatments in controlling hornworms was determined by counting the numbers of damaged plants. It was found that DDD gave the best and DDT the poorest control, the latter being apparently less effective than calcium arsenate against these insects. Moreover, the tomato hornworm [*Protoparce quinquemaculata*, Haw.] was the predominant species throughout the season, and the tobacco hornworm [*P. sexta*, Joh.], which also occurs on tomato, has been found to be much less susceptible to DDT [*R.A.E.*, A **36** 87].

Yields were much greater on all treated plots than on untreated ones, on which caterpillar infestation was heavy. Among treatments, the lowest yield was obtained with 5 per cent. DDT and the highest with 5 per cent. DDD, though it is possible that none of the differences was significant. Tomatos treated with 3 and 5 per cent. DDT showed a trace of DDT and 0·59 part per million, respectively, when picked on 5th September.

TYNER (M.). **Dilroc—a new Insecticide Diluent.**—*Agric. Chem.* **2** no. 4 pp. 41, 43, 65, 67, 2 figs., 4 refs. New York, N.Y., 1947.

Florida limestone can now be ground in commercial quantities to the fine particle-size required for insecticide diluents, and in this form, known as Dilroc, it shows promise of being useful. Its particle size and oil absorption value are similar to those of talc, pyrophyllite and clay and its bulk density is about twice as great. Tests of its reactivity showed that it had no effect on DDT either immediately or after storage for a year.

CULLINAN (F. P.). **Effects of some of the newer Organic Chemicals on Plant Life.**—*Agric. Chem.* **2** no. 5 pp. 18–20. New York, N.Y., 1947.

This paper includes the results of experiments carried out in Maryland on the effect on plants of the application of DDT to the foliage, as for insect control, and of the application of DDT and other chlorinated hydrocarbons to the soil in which they are grown. During the summer of 1945, a dust of 10 per cent. DDT in pyrophyllite, with or without sulphur, severely injured young plants of yellow crookneck squash, but had little effect on older plants and none on peas, cabbage, onion, turnip, potato, beans, tomato, cantaloupe melon, cucumber or sweet maize. In 1946, one application of a spray of 0·6 lb. technical DDT (as a 50 per cent. wettable powder) per 100 U.S. gals. water caused severe injury to the squash and some injury to the foliage of potato and bean, but none to peas, cabbage, turnip, tomato or beet.

In tests in which DDT was mixed with Chester clay loam, Sassafras sandy loam, Evesboro fine sand and muck in greenhouse benches, and vegetable crops were sown in the soils, 25 lb. technical DDT per acre depressed or retarded the growth of cantaloupe melon, cucumber, yellow crookneck squash, beet, spinach, tomato and beans in the lighter soils, but had no effect on maize, turnip, cabbage, broccoli or radish. In muck soils, 25 lb. DDT per acre had a slight effect on the more sensitive plants if they were planted immediately and none if they were planted two months after the soil was treated with DDT, but the addition of lime to the treated soil resulted in depressed growth of some crops. Three months after the DDT was added to the acid muck soils, dosages as high as 1,000 lb. per acre were not toxic to the plants, whereas in muck soils in which lime had been mixed, the toxicity of DDT to plants grown in the soil remained constant.

There was some indication that decomposition products of DDT are also injurious to plants. When sulphone, one of the by-products of technical DDT, was added as a trace, injury was much more severe, and a more highly purified form of p, p'DDT was less toxic than some of the technical forms of DDT. Fairly small proportions of γ benzene hexachloride in the soil were highly toxic to all the plants tested, and chlordane and toxaphene caused a retardation of plant growth with no obvious symptoms when added at relatively low dosages.

These insecticides all appear stable, resistant to soil micro-organisms and insoluble in water, but little is known of their permanence and stability under all soil and climatic conditions ; soil type and character, especially the quantity of organic material or colloidal clay present, are important factors in determining their toxicity, but the data from soil residue experiments carried out for two

years indicate that they should be used with caution and at minimum concentrations until their permanent effects are better understood. No phytotoxic effects have been observed when DDT was used on the fruit and foliage of apple, pear, plum, quince, nectarine or *Citrus* at concentrations that gave satisfactory insect control, or when benzene hexachloride was used on apple, peach or plum.

KIDO (G. S.) & ALLEN (T. C.). **Colloidal DDT. Its Use in Insecticide Sprays.**—*Agric. Chem.* **2** no. 6 pp. 21–23, 67, 69, 3 graphs, 3 refs. New York, N.Y., 1947.

In an attempt to eliminate the undesirable features of DDT sprays made from wettable powders, emulsifiable oil preparations and solutions in kerosene, liquid concentrates were prepared consisting of finely divided DDT particles, most of them approximately one micron in size, but some 30 microns long and 2–3 microns wide, suspended in water ; flocculation was prevented by means of a dispersing agent. Such concentrates are described as colloidal dispersions of DDT, and consist of DDT, an emulsifying agent and water, with or without the addition of a suitable DDT solvent. Those containing a solvent had the better physical properties and were tested for insecticidal value [*cf.* also *R.A.E.*, B **37** 100] ; they consist of 40 per cent. colloidal DDT ; 20 per cent. of a mixture of a saturated hydrocarbon petroleum distillate and alkylated aromatic hydrocarbons ; 3–6 per cent. non-ionic emulsifying agent, such as an aromatic hydrocarbon with a polyethylene oxide side chain (*e.g.*, a polyglycol ether alcohol) ; and 34–37 per cent. water. They are of a creamy semi-solid consistency, pour readily and do not cake. They are stable under ordinary storage conditions and retain their physical characteristics at temperatures as high as 70°C. [158°F.]. Freezing or storage at 4°C. [39·2°F.] for ten months solidifies them, but does not alter their properties when thawed. The settling rate of the diluted concentrate is slow compared with those of DDT wettable powders, and since only a small quantity of oil is present in the dispersion, all the DDT exists in a solid phase. Little noticeable residue remains on sprayed plant surfaces.

Greenhouse tests in which cucumber plants with two cotyledons and two true leaves were sprayed showed that the phytotoxicity of such dispersions was related directly to the amount of aromatic hydrocarbons present and was reduced by the inclusion of small quantities of insecticidal base oils ; and field tests in which a typical dispersion and a spray prepared from a 50 per cent. wettable powder were applied at concentrations as high as 8 lb. DDT per 100 U.S. gals. water to carrot, potato, pea, bean, lima bean, cucumber, sweet maize and tomato at various stages of growth indicated that neither was injurious to plant tissue when used at the dosages recommended for insect control.

A laboratory test of the effectiveness of the deposits from four DDT sprays, made from a colloidal dispersion, emulsifiable solution, micronised wettable powder and pulverised wettable powder, in which house-flies [*Musca domestica*, L.] were the test insect, showed that the first three were equally effective at concentrations of 1 and 2 lb. DDT per 100 U.S. gals. water, but that colloidal DDT was less effective than the other two at 0·25 lb. per 100 U.S. gals. The pulverised wettable powder gave the slowest knockdown under the conditions of the experiment. The deposit from a spray of 1 lb. colloidal DDT per 100 U.S. gals. water lost most of its toxicity after exposure to ultra-violet light for 48 hours, whereas the deposits from the other sprays were moderately toxic after such exposure.

In field tests to compare the insecticidal efficiency of colloidal and other types of DDT and to test the effect of Bordeaux mixture and an insoluble copper

fungicide on this, potatoes were treated with sprays containing ½ lb. DDT per 100 U.S. gals. with Bordeaux mixture (10 : 10 : 100) or tribasic copper sulphate, both at the rate of 2·5 lb. metallic copper per 100 U.S. gals. water. They were applied at the rate of 100 U.S. gals. per acre at weekly intervals, and counts were made of *Epitrix cucumeris*, Harr., and *Empoasca fabae*, Harr., two days after each treatment. The results showed that the emulsifiable DDT solution was the most effective, followed by wettable DDT and colloidal DDT, whether applied with Bordeaux mixture or tribasic copper sulphate. The superiority of the emulsified solution may have been partly due to the presence of Velsicol AR60, which enhances the toxicity of DDT as a contact insecticide. This spray should be used cautiously on other crops, as it tends to be phytotoxic. In the other sprays, Bordeaux mixture showed more tendency than tribasic copper sulphate to decrease the insecticidal efficiency of the DDT. All the DDT plots had lower insect counts and higher yields than a plot treated with Bordeaux mixture only. There was little difference in the appearance of the plants in the various plots during the growing season, but at maturity on 2nd August, plants on untreated plots were dead or dying, those treated with colloidal DDT or wettable powder were yellowing, and those treated with the emulsified solution were green. There was no noticeable difference in the date of maturity of plants treated with Bordeaux mixture and tribasic copper sulphate. Tests in which sprays were applied on 13th June and counts of insects were made on 15th and 21st June showed that the emulsified solution with Bordeaux mixture or tribasic copper sulphate gave the greatest kill on both dates. Wettable DDT powder gave good control on both, and colloidal DDT gave excellent initial control but rather poor control on the second date, especially of the flea-beetles. In a further test in which the amount of DDT was increased to 1 lb. per 100 U.S. gals. Bordeaux mixture (10 : 10 : 100), colloidal DDT again gave much less durable control of both insects than wettable DDT.

Hopperstead (S. L.). **Fungicidal Adhesive. Study of a polymeric organic Polysulfide which gives Sprays a fungicidal web-like Film, highly resistant to Rainfall.**—*Agric. Chem.* **2** no. 6 pp. 24–26, 71, 1 fig. New York, N.Y., 1947.

Certain polymeric organic polysulphides have shown promise as agricultural spray chemicals, and one of these, a polyethylene polysulphide, when sprayed on plants, forms a translucent, elastic, web-like film, which is fungicidal, strongly adhesive and highly resistant to rain. It has a particle size of 1–3 microns, is insoluble in water and the usual hydrocarbon solvents, is compatible with the standard insecticides and fungicides and can be used in combination with oil. When mixed with other spray materials, it increases the adhesiveness of the deposit ; its addition at the rate of 2 lb. per 100 U.S. gals. approximately doubled the residues of arsenic pentoxide left by sprays containing lead arsenate after a month with 5·65 ins. rain and increased by nearly six times the sulphur residue from wettable-sulphur sprays after six weeks with 9·7 ins. rain.

Greenhouse and field tests under a wide range of climatic conditions showed that the polymer was safe for use on most plants, but it accentuated the plant injury caused by high dosages of lead arsenate, owing to rapid build-up and persistence of spray deposit. Build-up of spray deposit is often so rapid, even under conditions of high rainfall, that dosages should be reduced by 33–50 per cent. to avoid injury.

In experiments on the control of the codling moth [*Cydia pomonella*, L.] on apple, the polymer, used at 1 lb. as an adhesive in sprays of 1 lb. DDT (as a wettable powder) per 100 U.S. gals. and of 3 lb. lead arsenate and 3 lb. lime per 100 U.S. gals., reduced the numbers of larvae and (in brackets) of

superficial injuries per 100 apples from 11 (29·5) to 3·7 (24·2) and from 25·2 (271) to 20 (152·5), respectively. In some cases, the polymer was ineffective or reduced efficiency, and this was found to be due to the presence of wetting agents in the mixtures. It was shown during 1946 that wetting agents, spreaders or dispersing agents should not be used with polyethylene polysulphide.

MARTIN (J. T.) & BRIGHTWELL (S. T. P.). **The Determination of the Pyrethrins in Pyrethrum Concentrates in Mineral Oil.**—*J. Soc. chem. Ind.* **65** p. 379 repr. 9 pp., 11 refs. London, 1946.

BRAY (G. T.) & LORD (K. A.). **The Determination of the Pyrethrin Content of dilute Preparations of Pyrethrum Flowers in Oil.**—*T.c.* p. 382 repr. 5 pp., 2 refs.

The following is based on the authors' summary of the first of these papers. A method is described for the determination of pyrethrin I in pyrethrum concentrates in light and heavy mineral oils. It is based on the mercury reduction method of Wilcoxon as modified by Holaday [*cf. R.A.E.*, A **26** 330] and utilises the separation of chrysanthemum monocarboxylic acid and the reduction of Denigès' reagent. Modifications concerned with the initial removal of uncombined acids, the removal of the oil and the separation of the monocarboxylic acid have been introduced.

The following is the authors' summary of the second paper. The Martin-Brightwell modification of the Wilcoxon-Holaday mercury reduction method, which was drawn up for the evaluation of pyrethrum preparations in mineral oil containing 6 per cent. of total pyrethrins, has been critically examined and modified to give accurate results for dilute preparations containing less than 0·2 per cent. total pyrethrins.

MARTIN (Hubert). **Insecticides : Chemical Constitution and Toxicity.**—*J. Soc. chem. Ind.* **65** p. 402 repr. 4 pp., 46 refs. London, 1946.

The following is mainly the author's summary of this review of chemical investigations on organic insecticides. Of the several ways of studying the relationships between molecular structure and toxicity, the analytical method, in which the effects of modification and dissection of the molecule are followed, is applicable to insecticides of insignificant vapour pressure at ordinary temperatures. The effect on the insecticidal properties of nicotine, rotenone and the pyrethrin synergists allied to sesamin of modification of their molecular structure is discussed, and the importance of physical properties affecting the distribution of the insecticide between the biophase in which it acts and the phase in which it is applied is illustrated for the aliphatic thiocyanates. The reasons for the insecticidal value of DDT are discussed [*cf. R.A.E.*, A **35** 203] and it is concluded that they comprise the ability to penetrate and to concentrate at the site of action within the organism, adequate stability to reach this site of action and ability to release hydrogen chloride when adsorbed at the site of action. It is shown that the possibility of ready dehydrochlorination is requisite for insecticidal properties in this series [but *cf.* **36** 274–275], and it is considered likely that the same applies to other chlorinated hydrocarbons.

WINTERINGHAM (F. P. W.) & HARRISON (A.). **The Permeability of proofed Fabrics to Fumigants.**—*J. Soc. chem. Ind.* **65** p. 409 repr. 4 pp., 2 figs., 4 refs. London, 1946.

The use of gas-proofed fabrics in the control of insect infestation of stored food or other products by fumigation may be more practicable or convenient

than the use of brick or steel chambers, and a method of measuring the fumigant permeabilities under atmospheric conditions of the various types of proofed fabric available is therefore desirable. An apparatus for this purpose, the experimental procedure, and the method of calculating a permeability constant for the material from the results are described. The permeability constants of a number of samples of proofed fabrics for methyl bromide at concentrations of 10–100 mg. per litre, at constant temperatures of 20·5 and 30°C. [68·9 and 86°F.] and a constant relative humidity of 70 per cent. and for hydrogen cyanide at 20–60 mg. per litre at 20·5°C. and 70 per cent. relative humidity were determined, and the effect of abrasion and creasing on the permeability of the samples to methyl bromide at 20·5°C. was tested. The results are tabulated, and it is concluded that the transmission through the fabrics of each of the gases is so complicated that it is difficult to decide which factors chiefly affect permeability, though it was clear that temperature had a marked effect on it. The balloon fabric permeability constants are very much greater for methyl bromide than for hydrogen, although the hydrogen molecule is the smaller, which suggests that physical sorption of the methyl bromide by the polymer layers is important in the transmission mechanism ; this is probably also true for hydrogen cyanide. With some materials, such as rubberised fabrics, there was evidence of chemical reaction between the diffusing methyl bromide and the proofing, possibly consisting of the methylation of sulphur groups present in the rubbers. From the results it appears that of the fabrics tested, those proofed with polyvinyl chloride or butyl rubber and a light oil cloth would justify field tests. The negligible effect of wear on an interply sample showed the advantage of protecting the proofing against wear.

Green (N.) & Carter (R. H.). **Pyrethrin I Determination. The Effect of Light in causing Variations in experimental Results.**—*Soap & sanit. Chem.* **22** no. 7 pp. 148A, 148C, 10 refs. New York, N.Y., 1946.

It has been observed that when the reaction between Denigès' acid mercuric sulphate reagent and a solution containing pyrethrin I [*cf. R.A.E.*, A **37** 184, etc.] is carried out in bright sunlight, the usual colour changes do not take place. Since this series of changes is used as a qualitative test for the pyrethrins and is probably the only such test known, investigations on the reaction were carried out. It was found that when the test is made in sunlight, the solution becomes reddish purple as usual, but immediately fades, and that putting the solution in sunlight for about five minutes at any stage of the reaction induces fading. Other sources of light, including a mercury-vapour lamp, a 15-watt fluorescent lamp and a 60-watt incandescent bulb all caused fading. Although a wide range of values was obtained, no definite conclusion could be drawn from tests to determine whether such bright light also affects the amount of mercury reduced to the mercurous state, because of temperature variations, which were known to affect the mercury reduction method. Further tests were therefore begun in which the temperature was kept constant, and these appear to show a somewhat smaller range of values.

Hazen (A. C.) & Goodhue (L. D.). **Insecticidal Aerosols. Stability in Storage studied by Accelerated Aging Tests.**—*Soap & sanit. Chem.* **22** no. 8 pp. 151, 153, 155, 6 refs. New York, N.Y., 1946.

The results are given of further accelerated ageing tests to determine the effect of adding various stabilisers or inhibitors to aerosol solutions to prevent their alteration in storage [*cf. R.A.E.*, A **35** 412]. Various metals, such as tinned iron, aluminium, stainless steel, and iron alone and copper and iron together were used in the tests.

For the rapid evaluation of stabilisers, an agricultural aerosol solution containing DDT, cyclohexanone, Velsicol, acetone and methyl chloride (5 : 5 : 5 : 35 : 50) was used as an indicator. The acetone contained some moisture, which, in the presence of methyl chloride and DDT, causes failure within 2–3 days under the conditions of the test. The results showed that 0·25 per cent. propylene oxide had some stabilising effect and 1 per cent. prevented failure for 43 days, after which the test was discontinued. Other epoxy compounds, such as 3, 4-epoxy-1-butene, alkyl glycidyl ether, ethyl butyl glycidyl ether, phenyl glycidyl ether and diglycidyl ether, were also good stabilisers. All these compounds are somewhat toxic to animals, but are unlikely to be dangerous in such small amounts. Sodium carbonate on filter paper stabilised the agricultural formula for 24 days, but in an aerosol solution containing 20 per cent. pyrethrum extract, DDT, pentane, deodorised kerosene and Freon-12 (dichlordifluoromethane) (4 : 1 : 15 : 8 : 72), which remained unchanged for 150 days without a stabiliser in the presence of tin, it caused polymerisation of the pyrethrum; sodium bicarbonate also caused polymerisation of the pyrethrum, but not so readily. The fact that sodium carbonate acts as a stabiliser indicates that elimination of free hydrochloric acid is the important requirement [*cf. loc. cit.*].

Propylene oxide and other epoxy compounds were also effective when copper and iron strips were used together in an aerosol solution of pyrethrum extract, DDT, APS-202 (an aromatic petroleum solvent) and Freon-12 (2 : 3 : 12 : 83), a combination that ordinarily fails quickly. Dicyclohexylamine, pyridine, ethylaniline and N-mono-n-butylaniline were not good because precipitates and tar were formed and colour formation occurred. Tests of four of the DDT solutions with no metal strips showed that changes take place that are not due to the metal. Two low-pressure aerosol solutions, containing pyrethrum extract, DDT, xylene and Freon-142 (chlordifluoroethane) (3 : 2 : 8 : 87) and Pyrenone 100 (a mixture of pyrethrum extract and piperonyl cyclohexenone), DDT, xylene and Freon-142 (5 : 2 : 6 : 87) remained unchanged for 27 days in the presence of iron. A solution of pyrethrum extract, γ benzene hexachloride, APS-202 and Freon-12 (3 : 2 : 10 : 85) kept for 58 days without a stabiliser.

It is concluded that failures apparently result from conditions caused by the liberation of hydrochloric acid. This can be controlled by the addition of propylene oxide, and since 0·25 per cent. of this compound has some stabilising effect on the agricultural aerosol solution, it can be assumed that a formula that will last for 90 days without a stabiliser would last almost indefinitely with 0·5 per cent. propylene oxide.

Pearsall (D. E.) & Wallace (P. P.). **Insecticidal Cords. A convenient Method of generating insecticidal Smoke by burning Cords impregnated with DDT or other Toxic Materials.**—*Soap & sanit. Chem.* **22** no. 10 pp. 139, 141, 143, 161, 163. New York, N.Y., 1946.

The authors describe a method for applying DDT and other insecticides that can readily be volatilised by heat by impregnating a combustible cord with them and vaporising them by the controlled heat produced when the cord is burnt. Rotenone, pyrethrum, nicotine and DDT have been employed successfully, but DDT appeared so promising that cord containing it has been used almost exclusively during the period of testing. The proprietary name Cordacide has been given to the product.

On ignition, the cord burns rapidly, and the DDT is dispersed in the air as a voluminous whitish vapour composed of extremely minute particles, in which form it is very efficient in killing insects that are susceptible to DDT poisoning. Completeness of vaporisation and a low degree of decomposition of

the DDT incorporated in the cord are obtained by proper heat balances and by suitable physical structure of the cords. The concentration produced by burning one foot of cord, containing about 400 mg. DDT, for each 60 cu. ft. of space gave complete knockdown of *Musca domestica*, L., in 30 minutes. Since the vaporised DDT is suspended in the air as such small particles, the time required for complete deposition is 1–2 hours, which is considerably longer than that for atomised sprays or the ordinary aerosols. The thickness and weight of the deposit are determined by the vapour concentration and exposure time, and one hour of exposure produced a residue on screen cages that was effective for four weeks after treatment.

A number of tests showed that larvae of *Tineola biselliella*, Humm., put on cloth two weeks after it had been exposed for 1½ hours to DDT vapour from cord used at the rate of 1 ft. per 30 cu. ft. and kept for 28 days were all killed ; a moderate amount of nap feeding had taken place and a few small holes were visible, the loss in weight being 3·5 per cent. as compared with 21·6 per cent. for untreated cloth. Similar treatment failed to kill larvae of *Attagenus piceus*, Ol., but only light nap feeding occurred and no holes were made, the loss in weight being reduced from 13·5 per cent. of untreated cloth to none of treated cloth. In tests under natural conditions in buildings of different sizes infested by various household pests [*cf.* also *R.A.E.*, B **37** 105], including *Lepisma saccharina*, L., carpet beetles and clothes moths, the cord used at the rate of 1 ft. per 50 or 60 cu. ft. space with an exposure time of two hours gave practically complete kills. *Adalia bipunctata*, L., and other unidentified Coccinellids, which were abundant in several of the dwellings treated, appeared to be unaffected by the DDT vapour or deposit.

Gersdorff (W. A.) & Barthel (W. F.). **Determination of Pyrethrins Deterioration.**—*Soap & sanit. Chem.* **22** no. 10 pp. 155, 157, 1 ref. New York, N.Y., 1946.

In the course of work on the preparation of purified pyrethrum concentrates [*cf. R.A.E.*, A **33** 189], it was found that partly polymerised or altered samples of pyrethrum were no longer completely soluble in dichlordifluoromethane, and tests were carried out to determine whether the relative amount of material insoluble in this solvent might be used as a criterion of the deterioration of highly concentrated pyrethrum preparations. The following is substantially the authors' summary. A purified pyrethrum concentrate (100 per cent. pyrethrins and cinerins) alone and with the addition of 0·1 per cent. hydroquinone, a sample diluted with deodorised kerosene to contain about 12 per cent. pyrethrins, and a commercial 20 per cent. concentrate were stored in the dark at 2 and 40°C. [35·6 and 104°F.] and in the light (but not direct sunlight) at room temperature. Periodical examinations were made for polymerisation by determining the solubility of the samples in dichlordifluoromethane, and their toxicity to *Musca domestica*, L., was determined at the end of 170 days. The results indicated that solubility in dichlordifluoromethane was a good indicator of deterioration.

There was no loss in toxicity in any of the samples when they were stored in the dark at 2°C. At higher temperatures, they tended to lose toxicity in the absence of an inhibitor, and this loss was much greater in the samples of 100 per cent. pyrethrins than in the less concentrated materials. Hydroquinone at a concentration of 0·1 per cent. proved to be a good inhibitor of loss of toxicity in this concentrate, and deodorised kerosene, used as a diluent, also inhibited loss of toxicity. The commercial concentrate showed considerable deterioration in 170 days at room temperature and still more at 40°C.

Ludwig (D.). **The Effect of DDT on the Metabolism of the Japanese Beetle, *Popillia japonica* Newman.**—*Ann. ent. Soc. Amer.* **39** no. 3 pp. 496–509, 6 graphs, 10 refs. Columbus, Ohio, 1946.

To determine whether the effect of DDT on insects is to produce modifications of the metabolic processes that eventually lead to death, examples of all stages of *Popillia japonica*, Newm., were exposed to DDT by contact with filter paper moistened with solutions and some adults by placing a drop of solution on the head, and they were then compared with normal examples in respect to weight, rate of desiccation over anhydrous calcium chloride and contents of water, glycogen, glucose, fat and protein.

The following is virtually the author's summary. Different stages in the life-cycle of *P. japonica* vary greatly in their susceptibility to DDT. Embryonic development is not affected, but when the eggs are exposed early in development, hatching is delayed. Exposed pupae show no characteristic signs of poisoning, but in some cases an abnormal emergence from treated pupae occurs. The larvae are killed by contact with 5 or 10 per cent. solutions and the adults by contact with 0·2 per cent. solutions in groundnut oil. This difference in susceptibility may be correlated with the relative amount of active tissue in the larva and adult. Poisoned larvae maintain their normal percentage of water although they lose about a third of their original weight. The decreased weight is the result of a loss of water, faeces, glycogen, glucose and fat. No significant loss of protein occurs. Poisoned adults lose about a tenth of their original weight, and this loss is accompanied by a reduction in water content. DDT appears to affect the ability to withstand desiccation, poisoned larvae and adults losing water over calcium chloride at a greater rate than normal ones. Its action may be correlated with the increased activity of the poisoned insect, which results in a greater rate of production and loss of metabolic water. Pupae exposed to groundnut oil without DDT or to DDT solutions in groundnut oil lose weight over calcium chloride at a greater rate than normal pupae. In this case, the greater loss of weight is believed to be associated with some physical action of the oil on the water permeability of the cuticle. The oil may bring about this effect by dissolving a waxy covering from the surface of the pupa.

DDT poisoning of the larva results in an increase in the rate of oxygen consumption, which becomes evident about two hours after exposure and reaches a maximum value of twice the normal rate within 24 hours. The rate continues above normal for five days, after which it declines until the insect dies. Adults poisoned with DDT show an immediate increase in oxygen utilisation, the rate reaching twice the normal value in 15 minutes with high concentrations of DDT, and in 30 minutes with low concentrations. The maximum value averages 3–4 times the normal rate, regardless of concentration. The increased oxygen consumption in both stages is correlated with increased muscular activity and is present only as long as the insect shows characteristic tremors.

The metabolic changes following a lethal exposure to DDT suggest that, in the larva of *P. japonica*, the increased muscular activity associated with DDT poisoning results in a rapid utilisation of the carbohydrate reserve, after which the insect dies.

McKelvey jr. (J. J.), Cuevara (J.) & Cortés (A.). *Apion* **Pod Weevil : a Pest of Beans in Mexico.**—*J. econ. Ent.* **40** no. 4 pp. 476–479, 6 refs. Menasha, Wis., 1947.

Pod weevils of the genus *Apion* have been reported several times as injuring beans grown in Mexico, but have been diversely identified as *A. godmani*, Wagner, or other species [*cf. R.A.E.*, A **10** 423] and the identity of the species

that causes the damage is still in doubt. Surveys made during the last few years have indicated that it is one of the most destructive pests of beans in some parts of Mexico and seriously limits bean production, and counts made on beans from many parts of the republic showed that practically all varieties of *Phaseolus vulgaris* commonly grown there are damaged. The weevil has not been found on soy beans or chick peas [*Cicer arietinum*], although it has been recovered from wild plants of the genera *Dalea*, *Desmodium*, *Rhynchosia* and *Tephrosia*. A survey in 1946 showed that it occurred generally on beans and other plants throughout the principal bean-producing areas of Mexico, the degree of infestation varying from 1–7 per cent. in Zacatecas and Aguascalientes to 80–90 per cent. in Michoacán. It was collected from as far north as Saltillo, Coahuila, and as far south as Tuxtepec, Oaxaca, and Tuxtla, Veracruz.

Adults appear in the fields when the beans are flowering and feed on the nectar, leaves and young pods without causing appreciable damage. The females oviposit in small pods and the larvae can be seen in these about 12 days later ; the larval and pupal stages and the complete life-cycle last about three, two and seven weeks, respectively. Pupation occurs in the holes excavated in the seeds by the larvae. The larvae do not feed on the fully ripened dried seeds and are therefore not a menace as pests of stored beans.

Weekly examinations of pods from beans planted every two weeks from 27th April until 28th September, 1946, showed no evidence that appreciable control could be obtained by altering planting dates. A slight but consistent seasonal increase in infestation occurred owing to the expected increase in number of adults during the middle and end of the season. In 1945, preliminary field experiments showed that sprays containing 1 lb. technical DDT per 100 U.S. gals. water gave good control of *Apion* ; suspensions gave better results than emulsified solutions owing to the phytotoxic effect of the latter. In 1946, in experiments in which applications were made at the rate of 100 U.S. gals. per acre when the majority of the beans were in blossom and at intervals of seven days for six weeks, sprays of 2 lb. DDT from wettable powders (Gesarol AK50 or Deenate 50W) per 100 U.S. gals. and of 6 or 8 lb. benzene hexachloride (7·5 per cent. γ isomer) per 100 U.S. gals. reduced the infestation by more than 95 per cent. and were superior to a spray of 4 lb. benzene hexachloride and much better than 2 lb. lead or magnesium arsenate with a spreader, 6 lb. cryolite, 12 lb. Bordeaux mixture or 0·5 lb. rotenone (3·7 per cent.) per 100 U.S. gals. An experiment in which plots received 1–6 weekly applications of 2 lb. 50 per cent. water-dispersible DDT per 100 U.S. gals. from 14th August, 1–5 from 21st August, 1–4 from 28th August, 1–3 from 4th September, 1–2 from 11th September or one on 18th September, respectively, showed that the first application, on 14th August, at the time of flowering, was as effective as any other combination of applications within the same series and better than any other treatment or combination of treatments delayed one or more weeks, and it should therefore be possible to reduce the number of applications to one or two, depending on the length of the flowering period of the bean variety in question. Another test afforded some indications that the dosage of DDT could be lowered, and if additional tests show that lower concentrations are equally effective, their use would probably result in less damage to beneficial insects present in the fields during flowering time.

ROMNEY (V. E.). **DDT Emulsion to control Red Spider and Mealybugs on Guayule.**—*J. econ. Ent.* **40** no. 4 pp. 480–483, 9 refs. Menasha, Wis., 1947.

Tetranychus bimaculatus, Harvey, and *Phenacoccus gossypii*, Tns. & Ckll., have been pests of guayule (*Parthenium argentatum*) grown experimentally in greenhouses at Salinas, California, since early in 1943. Preliminary tests in 1944 showed that single applications of a spray containing 0·3 per cent. DDT

caused an average reduction of 94·5 per cent. of the mites and eggs in 6–9·5 days, but killed only 33 per cent. of the females of *P. gossypii* in seven days, though the first two instars were very susceptible and the deposit remained toxic long enough to kill most of the progeny.

In tests made in 1945, a concentrate made by dissolving 3 gm. DDT in 6 gm. benzene and adding 3 gm. white oil and 10 gm. of a 1 per cent. solution of Vatsol OT (an emulsifier containing dioctyl sodium sulphosuccinate) was diluted to make 1 litre of emulsion (0·3 per cent. DDT). When applied to potted guayule plants at a pressure of 60 lb. per sq. in., this spray gave complete mortality of the mites and mealybugs within 48 hours and did not injure the most susceptible types of growth of the plant even after repeated applications. All the eggs of the mite were killed ; parts of some egg-masses of the mealybug escaped, but most of the mealybugs were killed after hatching by the residue on the plant. Substituting butyl acetate, propylene dichloride or methyl isobutyl ketone for the benzene caused no difference in the effectiveness of the emulsion against *T. bimaculatus*, but methyl isobutyl ketone precipitated some DDT on dilution with water. Cheap solvents, such as xylene and toluene, scorched the more susceptible growth of the plant.

When different concentrations of DDT were tested against the mite and the amount of benzene in the formula was reduced to 4 gm., there was a highly significant difference between the kills given by 0·05 and 0·1 per cent. DDT (95·74 and 99·38 per cent.), a significant difference between 0·1 and 0·2 per cent. (99·9 per cent.) and no significant difference between 0·2 and 0·3 per cent. (99·99 per cent.). The last emulsion did not contain enough benzene and lost some DDT on dilution with water. There was no significant difference in the kill of mealybugs by 0·1 and 0·3 per cent. DDT in the standard emulsion (99·49 and 99·91 per cent.), but the lower concentration caused a slower knock-down, and less complete kill of egg-masses, though the spray residue killed all young that hatched except a few that were on new growth. When DDT was omitted, the emulsions gave 49·45 and 8·36 per cent. mortality of the two pests, respectively.

Plummer (C. C.) & Shaw (J. G.). **DDT and Benzene Hexachloride to control Mexican Fruit Fly.**—*J. econ. Ent.* **40** no. 4 pp. 483–486, 3 refs. Menasha, Wis., 1947.

In 1945, four applications of a spray containing 2 lb. technical DDT, in an emulsified solution, per 100 U.S. gals. and three of a dust of 10 per cent. DDT in pyrophyllite gave 13 and 37 per cent. reduction in the numbers of larvae and puparia of *Anastrepha ludens*, Lw., recovered from mango fruits picked from treated trees in Cuernavaca, Morelos, Mexico.

In 1946, four applications, in the first and third weeks of May and June, of sprays containing about 6 lb. DDT (in water-dispersible preparations) per 100 U.S. gals. caused significant or highly significant reductions in the numbers of adults caught in traps throughout the season. Dusting with 20 per cent. DDT in pyrophyllite was much less effective owing to abundant rainfall, and four applications of 6 lb. water-dispersible benzene hexachloride (7·5 per cent. γ isomer) per 100 U.S. gals. were ineffective, although laboratory tests had shown benzene hexachloride to be more toxic to the adults than DDT. The numbers of larvae and puparia recovered from the fruits were reduced by 41 and 31 per cent. by the DDT spray and dust, respectively, but though consideration of further data from the plots sprayed with DDT showed that the final reduction was 62 per cent., it is considered probable that this fruit would still have had very little commercial value ; 25 per cent. more larvae and puparia were recovered from fruit from trees sprayed with benzene hexachloride than from fruit from untreated trees. The deposit from a spray

of water-dispersible DDT on mango leaves was highly toxic to caged fruit-flies 76 days after spraying, whereas that from benzene hexachloride showed no toxicity. DDT deposits on fruits were less effective than those on leaves.

FRAZIER (N. W.) & STAFFORD (E. M.). **Control of the Leafhopper *Erythroneura elegantula* on Grape with DDT and other Insecticides.**—*J. econ. Ent.* **40** no. 4 pp. 487–495, 2 refs. Menasha, Wis., 1947.

Tests on the use of DDT to control *Erythroneura elegantula*, Osborn, on grape-vines in the San Joaquin Valley [*cf. R.A.E.*, A **35** 111] were continued in 1946. A spray of 1·67 gals. extra light oil, containing 5 per cent. DDT, per 100 gals. water, applied on 30th April at the rate of 2–3 U.S. quarts per vine (1–1·2 lb. actual DDT per acre), an emulsive light oil containing 5 per cent. DDT applied to each row at the rate of 2·6 U.S. gals. per acre on 11th May from a thermal aerosol fog generator utilising superheated steam under pressure, vapour-sprays, consisting of 2·4 per cent. DDT in vapour-spray base oil and 5 per cent. DDT in equal parts of water and an emulsive light oil, applied to both sides of the rows at 4 U.S. gals. per acre on 11th May, and dusts containing 5, 7·5 or 10 per cent. DDT with dusting sulphur and an inert filler in various proportions applied on 23rd April at 10 lb. per acre all gave effective control. No apparent differences in control resulted from the use of dusts containing DDT prepared in micronised, non-micronised or fused forms with average particle sizes of 3·5, 10 and 10–12 microns. Dusts of 5 or 10 per cent. DDD (1, 1-dichlor-2,2-bis (p-chlorphenyl) ethane) with sulphur and an inert filler gave initial control comparable with that from DDT at the same concentrations, but apparently had less residual effect under the hot arid conditions of the experiment. Benzene-hexachloride dusts containing 0·5, 0·75 and 1 per cent. γ isomer were considerably less effective than the DDT dusts.

In order to avoid residues on the fruit, applications must be made before flowering time. Comparison of plots dusted on 23rd April, before egg deposition began and when the vines' growth was short and easily covered, and on 11th May, just after flowering had begun, to cover the maximum foliage growth as late as possible and kill the nymphs hatching from previously deposited eggs as well as the remaining adults, showed little difference in seasonal protection, but the former had fewer leafhoppers throughout the summer. Applications of dusts and vapour-sprays to both sides of every row gave better control than treating one side only when the treatment was made relatively late, but would be less advantageous during earlier applications, when the vine growth is short. The more efficient the equipment, the less would be the advantage of treating both sides of the plants; air blast and shape and adjustment of nozzles are important factors in determining adequate coverage. Allowing the aerosol to drift across from adjacent rows gave progressively less satisfactory control. DDT remained effective on the leaves for considerably longer when applied in oil than when used in dust mixtures; 0·65 lb. DDT per acre in a vapour-spray was as toxic 136 days after application as 1 lb. per acre in a dust 66 days after application. No toxicity of DDT residue to the leafhoppers was evident in any plot 152 days after treatment.

LANGE jr. (W. H.) & SMITH (L. M.). **Control of a Leaf Miner on Peas.**—*J. econ. Ent.* **40** no. 4 pp. 496–499, 1 graph. Menasha, Wis., 1947.

Liriomyza orbona, Mg., is a serious pest of peas and spinach in California. Its population drops during winter, but it increases in spring and summer and is very numerous in autumn; it has made the production of autumn peas so hazardous that their planting has been greatly curtailed. The position in the pea-producing areas has been made worse by the growing of sugar-beet,

which is one of its favourite food-plants and enables it to multiply during the spring and summer. Field evidence indicates that peas grown in the immediate vicinity of sugar-beet fields are more severely injured than others.

Commercial growers have obtained unsatisfactory control by repeated applications of a dust of lead arsenate and sulphur (3 : 7), or a light mist of oil containing 0·25 per cent. rotenone or 2·4 per cent. DDT. In laboratory tests carried out in 1946, deposits of chlordane in petri dishes gave higher mortalities in 16 hours than BHC (benzene hexachloride), DDT or hexaethyl tetraphosphate, though BHC gave higher initial kills than chlordane or DDT. In large-scale tests, a dust containing an inert ingredient, 25 per cent. standard lead arsenate and 50 per cent. sulphur, with 5 per cent. DDT in the first application and 10 per cent. in later ones, applied at about 25 lb. per acre on 9th, 19th and 31st July and 12th August in a field planted on 9th July, gave excellent control of the pea Aphid [*Macrosiphum onobrychis*, Boy.] and onion thrips [*Thrips tabaci*, Lind.] and some reduction in mining by *Liriomyza*, and applications of the dust containing 5 per cent. DDT on 13th and 23rd July and 3rd, 16th and 28th August at the same rate in another planted on 8th July reduced the average number of mines from 62·8 per plant in the controls to 6·2 and the populations of Aphids and thrips from about 1·5 of each per plant to zero. There were no rough pods caused by the rough pod mosaic, which is transmitted by *M. onobrychis*, Boy., on treated plants and 3 per cent. on untreated plants.

On small plots planted on 10th July and dusted on 29th July, 5th and 19th August and 1st and 10th September, 5 per cent. chlordane, with an inert carrier or 52 per cent. sulphur, reduced the numbers of mines by 98·7 per cent., and resulted in practically no adult feeding or egg punctures on the leaves and a scarcity of adults, whereas there were many adults, egg punctures and feeding punctures in adjoining untreated areas. The 5 per cent. DDT dust, one containing 5 per cent. BHC and 52 per cent. sulphur, and one containing 3 per cent. DDD, 1·2 per cent. β,β′-dithiocyanodiethyl ether and 48 per cent. sulphur all gave more than 80 per cent. reduction in number of mines, but 5 per cent. BHC without sulphur and 5 per cent. methoxy-DDT gave only 66·4 and 39 per cent. reduction, respectively. Peas from the plants dusted with BHC had an objectionable taste.

PLUMMER (C. C.) & SHAW (J. G.). **Toxicants in Oils for Control of the Citrus Blackfly.**—*J. econ. Ent.* **40** no. 4 pp. 499–504, 9 refs. Menasha, Wis., 1947.

Since the introduced parasite, *Eretmocerus serius*, Silv., has failed to control *Aleurocanthus woglumi*, Ashby, on *Citrus* on the west coast of Mexico [*cf. R.A.E.*, A **37** 107, etc.] because of the long dry season, experiments to find a spray for use against the Aleurodid were carried out in Cuernavaca, Morelos, to which it had spread from the coast. Eleven applications of emulsions containing kerosene or light-medium emulsive spray oil, each with and without small amounts of DDT, killed many larvae and pupae of *A. woglumi* on tangerine and orange trees, but none of the sprays was particularly effective. Four monthly applications from April to July of emulsions containing 0·75 and 1·5 per cent. light-medium tank-mix oil and from November to February of 0·875 per cent. light-medium or light emulsive oil or kerosene, all with 0·125 per cent. commercial dibutyl phthalate and with or without very small amounts of derris extractives containing 30 per cent. rotenone, did not give satisfactory control, though the addition of the rotenone greatly increased their efficiency.

In further field tests on Mexican sour lime, emulsions containing 1·67 per cent. commercial light-medium emulsive oil alone or with 0·9 oz. benzene hexachloride (18–20 per cent. γ isomer), toxaphene (25 per cent. active ingredient), chlordane or 50 per cent. Lethane 60 (beta-thiocyanoethyl esters of

aliphatic fatty acids) per U.S. gal. oil applied on 12th or 13th September, caused marked reductions in larvae of all instars. They were less effective than similar preparations containing derris powder to give 0·225 oz. rotenone per U.S. gal. oil, but the differences were not significant. On the basis of numbers of pupae, this last combination was significantly superior to any other treatment. The only other added toxicant that increased the effect of the oil was Lethane, but the difference was not significant. The toxaphene spray was the only one significantly inferior to oil alone and not significantly superior to no treatment ; it is thought that the high proportion of inert material mixed with the toxaphene reduced its toxicity. Leaf samples collected on 27th November, several weeks after the beginning of the dry season, showed very large increases in the numbers of larvae, and it was necessary to spray the trees again before they blossomed in winter. It is unlikely that infestation would have developed so rapidly if all the trees had been sprayed with an effective insecticide. A similar experiment with 1·67 per cent. light or light-medium emulsive oil, with or without 3 or 4·5 oz. cubé dust (5 per cent. rotenone) per U.S. gal., applied on 29th or 30th October, confirmed the value of adding dusts containing rotenone to oil. Light-medium oil was significantly better than light oil against first-instar larvae, but not against those in the third instar.

In a third experiment, navel oranges and sour limes growing in a mixed plantation were sprayed on 16th or 17th October. The sprays comprised 15 lb. 40 per cent. water-dispersible DDT and 2 oz. dried-blood spreader per 100 U.S. gals. water, a solution of 1·67 lb. technical DDT in 0·3 U.S. gal. xylene, 2 fl. oz. glyceryl dioleate and enough kerosene to make 3 U.S. gals. mixed with 1 oz. dried blood and 97 U.S. gals. water, and an emulsion of 1·67 per cent. light-medium emulsive oil containing 6 oz. powdered derris root (5 per cent. rotenone) per U.S. gal. On 30th October, the last two sprays had given practically complete control and the first had caused a marked reduction in the numbers of second- and third-instar larvae and pupae, and on 27th November, leaves from trees that had received them showed little increase in population. The derris spray appeared to be the most toxic to both larvae and pupae.

It is concluded that in Cuernavaca it is advisable to apply sprays containing 1·67 per cent. light-medium emulsive oil with 4·5 oz. derris or cubé powder (5 per cent. rotenone) per U.S. gal. oil at the beginning of the rainy season in May or June, provided that the fruit is large enough to minimise the possibility of injury, and that a second application will probably be necessary in September or October, near the end of the rainy season. It seems likely that blossoming and the small size of the fruit will preclude a third application between January and May.

Hervey (G. E. R.) & Schroeder (W. T.). **Life Cycle of *Macrosteles divisus* in Relation to Carrot Yellows in western New York.**—*J. econ. Ent.* **40** no. 4 pp. 505–508, 2 figs., 8 refs. Menasha, Wis., 1947.

Carrot yellows, caused by the aster yellows virus [*Chlorogenus callistephi* var. *vulgaris* of Holmes], which is transmitted by *Macrosteles divisus*, Uhl., has spread during the last few years in western New York. Surveys in 1944, 1945 and 1946 revealed an average infection of 30, 28 and 53 per cent., respectively, ranging from 5 to 78 per cent. in individual fields. The increase in 1946 accompanied an increase in leafhopper abundance, and the results are given of observations on the life-history of the Jassid in its relation to the development and spread of the disease in western New York.

It was found that *M. divisus* commonly overwinters on winter grains and grasses, probably in the egg stage. The nymphs were found on wheat, rye, barley and grasses in May and June. Collections with a net, made in a barley

field and a neighbouring carrot field at intervals of 3–4 days from early summer to late autumn showed that the Jassid matured and migrated from the barley between 20th May and the end of June; the approaching maturity of the barley appeared to hasten migration. Adults were first found on the young carrots early in June, nymphs were present from early July until the end of the season, and populations reached a maximum in August and then gradually decreased until harvest in October. Carrot yellows appeared as a trace on 9th July and spread steadily until harvest. During the early part of the season the percentage infection was highest in parts of the field nearest the barley, but at harvest it had become fairly uniform over the whole area and it was estimated that not more than 3–4 per cent. of the plants were healthy. Migration of *M. divisus* to winter cereals began early in October or as soon as these crops appeared, and adults were collected on wheat, barley and rye on warm days throughout October and November and in early December, in spite of the fact that air temperatures were below freezing point on 16 days during November and December. The numbers of leafhoppers collected decreased as the distance from the carrot field increased. Adults collected in the field in December gave rise to a brood of nymphs when caged with barley plants in the greenhouse and transmitted yellows to asters. Field-collected nymphs, chiefly in the second and third instars, caged with potted barley plants, showed no appreciable mortality when kept at a temperature of −1°C. [30·2°F.] for three days.

Becnel (I. J.), Mayeux (H. S.) & Roussel (J. S.). **Insecticide Tests for the Control of Cotton Boll Weevil and Cotton Aphids in 1946.**—*J. econ. Ent.* **40** no. 4 pp. 508–513. Menasha, Wis., 1947.

Field-plot experiments designed to test several insecticides against cotton insects, particularly the boll weevil [*Anthonomus grandis*, Boh.] and Aphids [*Aphis gossypii*, Glov.], were carried out in Louisiana during 1946. In the first, dusts containing 1·44, 2·88 and 5·17 per cent. γ BHC (the γ isomer of benzene hexachloride) in inert diluents and calcium arsenate alone and with 1 per cent. nicotine were applied at weekly intervals between 10th July and 14th August to cotton that had been planted on 12th April and was past the peak fruiting stage. The weevil infestation averaged 52 per cent. at the beginning of treatment, and an outbreak of bollworms [*Heliothis armigera*, Hb.] necessitated an application of 5 per cent. DDT on 2nd August. Leafworms [*Alabama argillacea*, Hb.] were controlled in untreated plots by cryolite on 16th August. The calcium-arsenate dusts and 5·17 per cent. γ BHC were equally effective against the weevil and significantly better than 2·88 and 1·44 per cent. γ BHC. All treatments were significantly better than none. In comparison with untreated plots, the numbers of Aphids were significantly increased by calcium arsenate alone, significantly reduced by 5·17 and 2·88 per cent. γ BHC, and slightly reduced by the other treatments. Red spiders [*Tetranychus*] were most numerous and injurious on plots receiving γ BHC. There were no significant differences in yield between treatments or between treated and untreated plots.

In the second experiment, dusts containing calcium arsenate alone, with 1 per cent. nicotine and with 0·359, 0·719 and 1·44 per cent. γ BHC were tested against *Anthonomus* and the Aphid. Seven effective applications were made between 4th July, when the first flowers appeared, and 16th August. All treatments gave significant control of the weevil; there was no significant difference between the first three dusts, but calcium arsenate was significantly better alone than with 0·719 or 1·44 per cent. γ BHC. Aphid infestation on untreated plots was significantly higher than on those treated with calcium arsenate and nicotine and significantly lower than on any others. There were

no significant differences in Aphid infestation between calcium arsenate alone and with γ BHC, indicating that there is no advantage in mixing them. The yields of plants treated with calcium arsenate with nicotine and calcium arsenate with 0·719 per cent. γ BHC were significantly higher than those from untreated plots, and the first was significantly better than all the other treatments. There was no significant difference in yield between calcium arsenate alone and with γ BHC.

In the third experiment, the initial application was made on 14th June against the cotton fleahopper [*Psallus seriatus*, Reut.] and the overwintered weevils, and the second was made on 20th June, washed off within 24 hours and repeated on 27th June. *Anthonomus* was increasing by 4th July, and four effective applications were made between that date and 26th July. The entire experimental area was dusted with calcium arsenate on 1st and 16th August against *Alabama* and *Anthonomus*, and as a result of Aphid increase after the first of these treatments, the experimental dusts were applied again on 9th August. The percentages of squares punctured by *Anthonomus* were 25·9 and 29·8 for 2·88 per cent. γ BHC with 50 per cent. sulphur and with pyrophyllite, 42·3 for calcium arsenate with 1 per cent. nicotine, 61·6 and 65·3 for 1·44 per cent. γ BHC with 75 per cent. sulphur and with pyrophyllite, 71·1 for calcium arsenate and sulphur (1 : 2), 80·1 for DDT and sulphur (5 : 85), and 83·3 for no treatment, the difference required for significance being 16·7. The mixtures containing sulphur prevented an increase of *Tetranychus* such as was usually associated with treatment with γ BHC and inert diluents in the other tests. All the γ BHC dusts and calcium arsenate with 1 per cent. nicotine gave effective control of Aphids, whereas dusts containing DDT or calcium arsenate and sulphur resulted in large increases over the controls. Yields were significantly higher on plots treated with calcium arsenate and nicotine or 2·88 per cent. γ BHC with pyrophyllite than on any others. The dust containing 2·88 per cent. γ BHC with sulphur was contaminated with a weed-killer (2,4-D) and the first application produced injury due to this. A fresh mixture was used for subsequent applications, but the plants did not completely recover and it is believed that the yields were significantly affected.

A large-scale experiment was carried out to compare applications of 5·75 per cent. γ BHC with alternate applications of calcium arsenate alone and with 1 per cent. γ BHC for the control of *Anthonomus*, *Heliothis* and the Aphid. Dusts were applied at the rate of about 8 lb. per acre at intervals of 5–7 days from 5th to 26th July. However, Aphids increased so rapidly on the calcium-arsenate plot after the first two applications that calcium arsenate with 1 per cent. nicotine was substituted for the dust of calcium arsenate and γ BHC. A light application of calcium arsenate was applied to the control plot on 21st August against *Alabama*. Both the calcium-arsenate dusts and γ BHC alone controlled the weevil, resulting in 25 and 14 per cent. injury, as compared with 80 per cent. for no treatment. *Heliothis* caused severe injury to squares and bolls on the plot treated with γ BHC but only slight injury on untreated plots and those treated with calcium arsenate (23, 7 and 5 per cent. squares injured on 26th July). Aphids were effectively controlled by γ BHC, but *Tetranychus* became numerous on this plot. The plot treated with calcium arsenate yielded more and that treated with γ BHC less than the control.

Ivy (E. E.), Parencia jr. (C. R.) & Ewing (K. P.). **A Chlorinated Camphene for Control of Cotton Insects.**—*J. econ. Ent.* **40** no. 4 pp. 513–517, 1 fig., 4 refs. Menasha, Wis., 1947.

The following is based on the authors' summary. Toxaphene (a chlorinated camphene [*cf. R.A.E.*, A **36** 395]) gave excellent control of several of the more important cotton insects in cage tests and two field-plot experiments at

Waco, Texas, during 1946. In the cage tests, a dust containing 20 per cent. toxaphene, applied at the rate of 16 lb. per acre, controlled larvae of *Heliothis armigera*, Hb., as well as a dust containing 5 per cent. DDT, and at 8 lb. per acre it controlled *Anthonomus grandis*, Boh., as well as calcium arsenate or a dust containing BHC (benzene hexachloride) at a concentration giving 5·75 per cent. γ isomer. At 16 lb. per acre, it controlled *Nezara viridula*, L., and *Trichoplusia ni*, Hb., and at 8 lb. per acre it controlled *Loxostege similalis*, Gn., at least as well as DDT, BHC or calcium arsenate. It was as effective against *Aphis gossypii*, Glov., at 10 lb. per acre as 2 per cent. nicotine dust but not so effective as BHC. A 10 per cent. toxaphene dust at 8 lb. per acre controlled larvae of *Alabama argillacea*, Hb., as well as calcium arsenate, and excellent control of adults and nymphs of *Psallus seriatus*, Reut., was obtained with a dosage of 12 lb. per acre and concentrations as low as 1 per cent.

In the field-plot experiments, a dust containing 20 per cent. toxaphene gave adequate control of comparatively heavy infestations of *Heliothis*, *Anthonomus*, *Aphis* and *Alabama*. It controlled *Anthonomus* about as well as calcium arsenate and was slightly superior to calcium arsenate against *Heliothis*. Mixtures of DDT and BHC (5 per cent. DDT with 2·88 or 4·5 per cent. γ BHC) appeared to be slightly better than toxaphene against *Heliothis* but about equal to it against *Anthonomus*, *Aphis* and *Alabama*. In the small-plot experiment, the yields of seed cotton, in pounds per acre, were 863 for toxaphene, 1,025 for the mixture of DDT and 2·88 per cent. γ BHC, 674 for calcium arsenate and 267 for no treatment, all differences being significant, and in the large-scale experiment they were 760 for toxaphene, 745 for DDT with 4·5 per cent. γ BHC, 442 for calcium arsenate and 218 for no treatment.

METCALF (R. L.). **Relative Toxicities of isomeric Hexachlorocyclohexanes and related Materials to Thrips.**—*J. econ. Ent.* **40** no. 4 pp. 522–525, 11 refs. Menasha, Wis., 1947.

The chlorination of benzene in the presence of ultraviolet light to produce the insecticide γ benzene hexachloride invariably results in the production of a number of stereo-isomers [*cf. R.A.E.*, A **33** 256]. Of 16 possible theoretical configurations, at least five have been identified as distinct chemical entities in the crude reaction product. Although these isomers differ widely in physical, chemical and biological properties, the separation and purification of the active γ isomer is so laborious that most insecticidal preparations will probably consist of mixtures of the isomers. It has been found that crude benzene hexachloride contains approximately 65–70 per cent. α, 5 per cent. β, 10–12 per cent. γ, 6 per cent. δ and 4 per cent. ε isomers, 4 per cent. benzene heptachloride and 0·6 per cent. benzene octachloride (1,1,2,2,3,4,5,6-octachlorcyclohexane), the last two being formed by the chlorination of monochlor- and dichlorbenzenes. In the presence of alcoholic alkali, the α, γ and δ isomers of benzene hexachloride liberate three moles of hydrogen chloride to form principally 1, 2, 4-trichlorbenzene and lesser amounts of 1, 2, 3- and 1, 3, 5-trichlorbenzenes; the ε isomer behaves similarly.

In view of the close structural similarity between the isomers and related materials, attempts were made to determine their relative toxicities and to find whether any of the "inactive" isomers exerted either synergistic or antagonistic effects on the toxic action of the γ isomer [*cf.* **37** 60]. The following is based on the author's conclusions. In tests in which adults of *Heliothrips haemorrhoidalis*, Bch., were left for 24 hours on oranges that had been dipped for one second in standard w/v acetone solutions of the materials and allowed to dry, comparison of the approximate median lethal concentrations of the solutions from which the deposits were obtained showed that the γ isomer of benzene hexachloride was about 10, 25, 50 and 100 times as toxic as p, p′ DDT,

toxaphene, chlordane and hexaethyl tetraphosphate, respectively. It was 1,000 and 10,000 times as toxic as the α and δ isomers and more than 10,000 times as toxic as the β and ε isomers. Benzene hexabromide, 1, 2, 4-trichlorbenzene, various heptachlorides and octachlorides of benzene and benzene enneachloride (1,1,2,2,3,4,4,5,6-enneachlorcyclohexane) were nontoxic at 1,000 times the median lethal concentration of γ benzene hexachloride. Mixtures of γ benzene hexachloride with each of the four other isomers at 10 or 100 times the concentration or with all four in several representative crude products were not significantly more or less toxic than the γ isomer alone at the same concentration, so that, from a practical standpoint, the insecticidal effectiveness of any mixture of isomers of benzene hexachloride against *H. haemorrhoidalis* is determined by the γ isomer content. A crude preparation of benzene hexachloride containing 2 per cent. γ isomer did not appear to have a significantly longer residual effect than pure γ benzene hexachloride applied at the same rate of γ isomer. Meso-inositol had no toxicity to the thrips at 500 times the median lethal concentration of γ benzene hexachloride, and its presence in this concentration had no influence on the toxicity of the γ isomer [*cf.* A **36** 277; B **36** 184; etc.].

Sun (Yun-Pei) & Hansberry (R.). **Site of Action of Contact Insecticidal Dusts containing Rotenone or Methylnaphthalenes.**—*J. econ. Ent.* **40** no. 4 pp. 526–529, 1 ref. Menasha, Wis., 1947.

To determine the relative importance of the site of action of insecticidal dusts that act by contact, dusts containing 0·1 per cent. rotenone or 2 per cent. of various methyl naphthalenes were applied to third-instar larvae of *Epilachna varivestis*, Muls., in four different ways. Three petri dishes, the first containing paper, leaf disks and larvae, the second paper and larvae, and the third leaf disks only, were dusted to give a deposit of 0·7 mg. per sq. cm., after which the first dish was kept as it was and untreated larvae and paper were added to the third. The larvae in the second dish were removed and provided with untreated leaf disks and paper and untreated larvae and, three hours later, leaf disks were placed on the treated paper. The effects of the different treatments and materials were determined by comparing the area of leaf consumed in 24 hours at room temperature. The methyl naphthalenes, in descending order of effectiveness, were 2,6-dimethylnaphthalene, Velsicol AR-60, 1,2-dimethylnaphthalene, Velsicol AR-50, 2-methylnaphthalene and 1-methylnaphthalene, and for these the descending order of effectiveness of treatments was application to paper, leaf and insects, to paper only, to leaves only and to insects only. It is concluded that these products act mainly by contact with the tarsi and the tip of the abdomen. With rotenone, dusting the leaves only was almost as effective as dusting all surfaces.

To test the relative importance of contact action on the body or the tarsi and the tip of the abdomen of *Macrosiphum onobrychis*, Boy. (*pisi*, Kalt.), dusted Aphids were kept in an undusted dish and undusted ones in a dusted dish for 24 hours. It was found that the figures for percentage mortality were more by 25, 24 and 5 when the dishes were dusted with 0·039, 0·078 and 0·16 per cent. rotenone, respectively, than when the Aphids were treated, whereas they were more by 4, 82 and 87 when the dishes were dusted with 1, 2 and 3 per cent. Velsicol AR-60 than when the Aphids were dusted. It appears that the difference in mortality caused by the difference in treatment is not great for rotenone at moderate effectiveness and rather small at high mortality, whereas it is very great for Velsicol AR-60 at moderate to high mortality. When the dust was applied to the bodies of the Aphids the percentage mortality was 64 for 0·039 per cent. rotenone and only 13 for 3 per cent. Velsicol, but when the Aphids were allowed to walk over the dust, it was 89 for rotenone and 100 for Velsicol.

It is concluded that the contact action of insecticidal dusts may be due either to dust on the body only or to an accumulation of dust on the tarsi and probably also the tip of the abdomen resulting from walking over a dusted surface. The latter appears to be more important for active than for inactive insects. Methylnaphthalenes were more effective against both *E. varivestis* and *M. onobrychis* when the insects crawled over a dusted surface than when their bodies were dusted, whereas rotenone dusts were about equal in effectiveness by either method of application, indicating that the vital site of action of the former is located in the tarsi, whereas that of rotenone may be the whole body surface.

Smith (C. E.) & Becnel (I. J.). **Effectiveness of different Forms of Nicotine in Cotton Aphid Control.**—*J. econ. Ent.* **40** no. 4 pp. 536–539. Menasha, Wis., 1947.

In field experiments carried out in north-eastern Louisiana in 1944–46, several concentrated dust preparations containing nicotine in a form that was highly soluble in water, but only slightly volatile (dry concentrate) and Black Leaf 155 (containing soluble and insoluble nicotine with low volatility), added to calcium arsenate at various concentrations, were compared with the recommended dust mixture of calcium arsenate and liquid nicotine sulphate against the boll weevil [*Anthonomus grandis*, Boh.] and Aphids [*Aphis gossypii*, Glov.] on cotton. Commercial calcium arsenate was used alone in all applications in one treatment and in alternate applications with all the mixtures tested. The dusts were applied at intervals of 4–5 days, beginning after fruiting was well started and continuing until severe Aphid infestations developed on the plots treated with calcium arsenate only. Statistical analysis of the results obtained in each year indicated that all the treatments tested were significantly superior to none in controlling the weevil and that there were no significant differences in weevil control between treatments in any year.

In 1944, there was significantly less Aphid increase on untreated plots and those treated with dusts of all three types containing 2 per cent. nicotine, with no significant difference between these, than on the plot receiving calcium arsenate only, and yields were significantly higher on plots treated with nicotine dusts than on that treated with calcium arsenate only, which did not differ significantly from no treatment. In 1945, calcium arsenate alone resulted in significantly higher Aphid populations than all other treatments or none, and mixtures containing 0·5 per cent. nicotine as the sulphate or dry concentrate or 1 per cent. as the sulphate did not alter the populations significantly from those in the control, while 1 per cent. as a dry concentrate and 2 per cent. as either significantly reduced them, with no significant difference between these treatments. As regards yields, the 2 and 1 per cent. nicotine dusts were significantly better than no treatment, with no significant differences between them, and the 2 per cent. dusts were significantly better than calcium arsenate alone or with 0·5 per cent. nicotine. There were no significant differences between no treatment and treatment with calcium arsenate alone and with 0·5 per cent. nicotine. In 1946, some additional treatments were tested. Against the Aphid, all treatments except calcium arsenate alone, which increased the population, and special calcium arsenate (Niakil) with 1·54 per cent. γ benzene hexachloride were significantly better than none, and the benzene-hexachloride treatment was inferior to all treatments containing nicotine whether as the sulphate or concentrate. All treatments gave significantly better yields than none, and the yields for mixtures of commercial calcium arsenate and nicotine were not significantly different from each other but were significantly better than those for Niakil with nicotine or with benzene hexachloride.

Fife (L. C.), Shiller (I.) & Chapman (A. J.). **Pink Bollworm Carry-over from one Cotton Crop to the next in the Lower Rio Grande Valley.**—*J. econ. Ent.* **40** no. 4 pp. 540–545, 3 figs., 3 refs. Menasha, Wis., 1947.

The following is substantially the authors' summary. Investigations to determine how *Platyedra* (*Pectinophora*) *gossypiella*, Saund., maintains itself in the interval between one cotton crop and the next in the Lower Rio Grande Valley of Texas and Mexico, a semitropical area, were carried out in 1939–45 [*cf. R.A.E.*, A **29** 430 ; **30** 250, 593 ; **31** 467 ; **33** 261 ; **34** 178 ; **35** 50].

The larvae were found to enter the resting stage in open cotton bolls in the field during the latter part of July, even though conditions were apparently still favourable for their development. Tests in hibernating cages showed that moths emerged in every month of the year from open cotton bolls on standing stalks, on the soil surface and at a depth of 1½ inches. Larvae surviving the winter and available to produce moths to infest cultivated cotton averaged 20·4 per cent. of those from infested bolls on standing stalks, 8·5 per cent. of those from bolls on the soil surface and 2·2 per cent. of those at a depth of 1½ inches. The winter survival from open bolls collected on 8th to 16th August, 11th to 18th September and 12th to 19th October and put in hibernation cages averaged 0·4, 5 and 26 per cent. respectively. Moisture applied artificially to infested bolls in the three positions reduced winter survival in all cases. Over a period of two years, the average percentages of survival in watered and unwatered bolls were 33·6 and 49·7 on standing stalks, 15·5 and 21·7 on the soil surface and 2·6 and 6·6 at a depth of 1½ inches, but the differences between the two series were not significant. According to moth emergence records in hibernation cages, the maximum durations of the larval diapause in open bolls in the three positions were 337, 276 and 276 days. Hibernation-cage tests showed that *P. gossypiella* can overwinter under natural conditions in the seed pods of *Pseudabutilon lozani* and okra (*Hibiscus esculentus*), and it would therefore seem advisable to plough both cotton and okra crop residues under as early and as deep as possible. Irrigation or heavy winter rainfall will reduce winter survival, and early planting and the use of varieties of cotton that mature early will make it possible to destroy the crop residue at an early date, thereby reducing the overwintering population that causes infestation of the next crop.

Wester (H. V.) & St. George (R. A.). **Life History and Control of the Webworm,** *Homadaula albizziae.*—*J. econ. Ent.* **40** no. 4 pp. 546–553, 3 figs., 2 refs. Menasha, Wis., 1947.

The authors briefly describe all stages and give further details of the life-history of *Homadaula albizziae*, Clarke, attacking *Albizzia julibrissin* in the neighbourhood of Washington, D.C. [*cf. R.A.E.*, A **31** 412], where it was first found in 1940. It was found 53 miles to the south-east in 1944, 105 miles south in 1945, 55–65 miles to the north and north-west in 1946, and 656 miles south, in Georgia, in 1947 ; its spread over the entire eastern United States is anticipated. The eggs are deposited in considerable numbers on the flowers of the tree early in the season, though later many are found on the leaves or on *Gleditsia triacanthos*. The flowering trees are preferred, and the sunny portions of the crowns are selected in preference to shady parts. The larvae feed on the foliage and green seed-pods of both trees and on the flowers of *Albizzia*, chiefly within or near their webs. Egg-laying continues throughout the season, so that eggs and larvae of various sizes are found together. In the laboratory, a single female laid 69 eggs over a period of four days, and the eggs hatched within 2–3 days. When fully grown, most of the larvae descend to the ground on silken threads, though some of the summer generation pupate in their webs

on the trees. There are two overlapping generations and a partial third in the year in the District of Columbia; adults from overwintered pupae emerge during early June, just before the first flowers appear, those of the first generation from about the middle of July until early August and those of the second during late August. During a normal season, the period of infestation extends from about 9th June to 6th November on *Albizzia* and for a shorter period on *Gleditsia*, which drops its foliage 2–3 weeks earlier. *Gleditsia* is subject to greater damage, as it does not produce new foliage so quickly as *Albizzia*, and small *Gleditsia* trees appear to be more heavily attacked than large ones.

From the results of control tests carried out in 1942–46, it appears that 1–2 applications on *Gleditsia* and 2–3 on *Albizzia* of a spray of 4 lb. lead arsenate and 1 U.S. quart summer spray oil per 100 U.S. gals. water, beginning when infestation is first detected and repeated at intervals of 4–5 weeks, will give satisfactory protection for the rest of the season. Sprays of 1 lb. DDT per 100 U.S. gals. give good initial mortality, and those containing 4 lb. DDT per 100 U.S. gals. give residual protection at least equivalent to that from the same concentration of lead arsenate.

Turner (N.) & Saunders (D. H.). **A Test for Synergism between DDT and Nicotine-bentonite in Dusts.**—*J. econ. Ent.* **40** no. 4 pp. 553–556, 3 figs., 6 refs. Menasha, Wis., 1947.

Investigations on the possibility of synergism between nicotine and DDT were carried out by applying dusts of fixed nicotine, DDT and mixtures of the two, all in pyrophyllite at concentrations of 1, 2, 4 and 8 per cent. active ingredients, to the tassels of maize on 8th August and to the developing ear shoots on 15th, 20th and 26th August for the control of the second-generation larvae of *Pyrausta nubilalis*, Hb. It was evident from the results that nicotine was much less effective than DDT and that the mixtures were intermediate in toxicity. The dusts containing three parts DDT and one part nicotine at all four concentrations and those containing equal quantities of DDT and nicotine at the three higher concentrations were less toxic than would be expected from the DDT content alone, indicating that the nicotine had an antagonistic effect, but the mixtures containing one part DDT and three parts nicotine and the 1 per cent. mixture of equal parts were consistently more toxic than would be expected on the basis of the DDT alone. These were the only combinations that showed any evidence of synergism, and in them it was too small to be measured and not statistically significant.

Cutright (C. R.) & Sutton (R.). **Effectiveness of Acaricides in DDT-sprayed Apple Orchards.**—*J. econ. Ent.* **40** no. 4 pp. 557–561, 6 figs. Menasha, Wis., 1947.

The chief problem resulting from the use of DDT in apple orchards is that of increased populations of the European red mite [*Paratetranychus pilosus*, C. & F.], which seems to become more injurious with each year of spraying, probably owing to high mortality of its predators. Investigations were carried out in Ohio on the value of applying acaricides or ovicides before the DDT in order to reduce the population enough to delay substantial recovery during most of the season, on their addition to DDT sprays to inhibit the growth of mite populations, and on their use to reduce populations that have already reached injurious numbers. In the first category, oil applied in the dormant or delayed-dormant spray or with a suitable fungicide in the calyx and first few cover sprays has given good control until late July or August when followed by sprays of lead arsenate and sulphur, but not usually for so long when DDT was used.

In the second category, summer oil used with DDT in 3–6 cover sprays has given good control of the mite as well as of the codling moth [*Cydia pomonella*, L.], but prevents the use of sulphur fungicides, which are almost essential in some areas, and may cause poor coloration of fruit, due to heavy spray residue, and severe foliage injury. It is therefore doubtful whether simple combinations of DDT and oil can ever be widely used, but a spray of 4 oz. actual DDT, 8 oz. nicotine sulphate, 4 lb. Mississippi bentonite and 2 U.S. quarts summer oil per 100 U.S. gals. water, applied 3–4 times during the latter part of two seasons after two cover sprays of DDT, gave excellent control of both codling moth and mite with no foliage injury and only slight dulling of fruit colour. Many compounds with acaricidal properties, including hydroxypentamethylflavan (flavan), rotenone and methoxy-DDT have their effectiveness greatly enhanced when combined with oil, but have the same disadvantages as DDT with oil, though the effects are not so pronounced owing to the smaller quantity of oil used. There are some situations in which they can be applied with advantage, but their use is limited.

Practically all acaricides can be combined safely with DDT, and the results are given of tests of various combinations in 1946. Flavan wettable powder, added to DDT sprays at 1 lb. actual flavan per 100 U.S. gals., reduced mite populations, though not to the point at which damage was averted, but caused foliage injury and bad coloration of fruit. Xanthone used at 2 lb. per 100 U.S. gals. in five applications prevented serious mite damage to foliage and resulted in good fruit colour, but used at the same dosage in two applications it did not give commercial control. Benzene hexachloride at 1½ lb. per 100 U.S. gals. (6 per cent. γ isomer) was ineffective. Rotenone in a commercial preparation (Neurote), used with DDT in five applications, gave less than 30 per cent. control, probably because the concentration was too low, but the foliage seemed to recover towards the end of the season and fruit finish was good. Two applications of 4 lb. ground cubé root (5·5 per cent. rotenone) and 1 U.S. quart summer oil per 100 U.S. gals. were fairly effective in a corrective schedule. A very promising material, referred to as DMC 25 per cent. [a 25 per cent. emulsifiable solution of diparachlorphenylmethylcarbinol], gave good mite control with no adverse effect on foliage or fruit when used at the rate of 1 pint per 100 gals. in two applications, and hexaethyl tetraphosphate was promising in limited tests. Up to the present, the dinitro compounds used with DDT have shown most promise for summer use against the mite. DN-111 [dicyclohexylamine salt of dinitro-o-cyclohexylphenol] has given good results in both preventive and corrective schedules, and a dormant dinitro powder, Dry Mix No. 1 [40 per cent. dinitro-o-cyclohexylphenol] has proved effective at 6 oz. per 100 U.S. gals., but needs more testing before it can be generally recommended.

The reduction of damaging mite populations has usually required at least two spray applications. In general, the corrective schedules were less effective than the preventive ones, but gave encouraging results. A combination of at least two of the three methods is at present the most practical means of assuring mite control. Summer spray schedules of either a preventive or a corrective nature were far more successful when preceded by dormant oil applications than when no early oil sprays were used.

LANDIS (B. J.) & DAVIS (E. W.). **Two-spotted Spider Mite Damage to Potatoes.** —*J. econ. Ent.* **40** no. 4 p. 565, 3 refs. Menasha, Wis., 1947.

Potato plants began to die prematurely in some fields in the Yakima Valley, Washington, during the latter part of July 1946, and by 30th September about 15 acres of the crop had been killed. Late blight [*Phytophthora infestans*] was responsible in some instances, but in others the blight was absent.

Tetranychus bimaculatus, Harvey, was present in the fields in large numbers. A few days after mites were found in the first field, they were observed in three other widely separated fields ; late blight was also present in one of these and caused the rapid death of the plants. In one field a maximum of 12 mites per compound leaf was found, but neither blight nor mite injury was observed, whereas in another a maximum of 71 per compound leaf was observed and the death of numerous plants was attributed to the mites. During October, several other potato fields were examined, and although numerous dead mite eggs were found, neither viable eggs nor living mites were observed. All the infested fields had been dusted with DDT once or more before the occurrence of damage, and the greatest injury occurred in fields that had received 4–5 applications at intervals of 12–15 days.

Landis (B. J.) & Getzendaner (C. W.). *Aleyrodes spiraeoides* **infesting Potatoes.**—*J. econ. Ent.* **40** no. 4 p. 567. Menasha, Wis., 1947.

Moderate to heavy populations of whiteflies have been observed on potatoes in the Yakima Valley of Washington every year since 1941 and may have been present for longer. Examples collected in 1946 were identified as *Aleurodes spiraeoides*, Quaint. The adults appear on potato foliage during the first half of May, and eggs have been observed as early as 14th May. The population increases slowly on early potatoes but extremely rapidly on the late crop, reaching a peak during August and September. Reproduction on potatoes is stopped by killing frosts, usually in October, but larvae and adults have been observed on more hardy weeds as late as the first week in November. Enormous populations were observed in potato fields that had been kept free from possible wild food-plants, and in one instance over 1,000 eggs were found on a single leaflet. As much as 1,363 per cent. increase in adult numbers during seven days in August has been recorded, and increases of 300–600 per cent. during a similar period were not uncommon.

The White Rose variety of potato was less heavily infested than either Netted Gem or Sebago. The Aleurodid breeds on several unrelated plants ; infested plants found in or near potato fields included species of *Physalis*, *Convolvulus*, *Atriplex*, *Sonchus* and tomato.

Weinman (C. J.). **Insecticide Tests on Codling Moth in Illinois, 1946.**—*J. econ. Ent.* **40** no. 4 pp. 567–568. Menasha, Wis., 1947.

Several new insecticides were tested against the codling moth [*Cydia pomonella*, L.] on apple in Illinois in 1946. All trees received the same pre-calyx, calyx and first and second cover sprays, after which the experimental materials were applied in four–six sprays, the number depending on the variety of apple. The results are given for one variety, but were similar for all. All insecticide quantities are per 100 U.S. gals. The percentages of apples (both fallen and picked) that were infested were 2·5 and 8·4 for 1 and ½ lb. DDT (as a wettable powder), 7·7 for 4 lb. lead arsenate with 2 U.S. quarts summer oil, 5·4 for 4 lb. zinc fluoarsenate and 2 U.S. quarts summer oil without a safener (which caused severe scorching, whereas the other sprays caused none) and 36–60 for 1 lb. chlordane or toxaphene (as wettable powders and emulsion concentrates) or 0·173 lb. benzene-hexachloride wettable powder (5·75 per cent. γ isomer). The benzene hexachloride affected the flavour of the fruit nearly ten weeks after the last spray had been applied.

Ivy (E. E.) & Ewing (K. P.). **Laboratory and Cage Tests with newer Insecticides to control Cotton Insects.**—*J. econ. Ent.* **40** no. 4 pp. 568–569, 3 refs. Menasha, Wis., 1947.

The results are given of laboratory and field cage tests of additional insecticidal dusts against cotton insects, carried out at Waco, Texas, in 1946 [*cf. R.A.E.*, A **37** 151, 195]. They were applied against *Heliothis armigera*, Hb., *Trichoplusia ni*, Hb., and *Nezara viridula*, L., at 16 lb. per acre, against *Psallus seriatus*, Reut., at 12 lb. per acre, against *Aphis gossypii*, Glov., at 10 lb. per acre and against *Anthonomus grandis*, Boh., *Alabama argillacea*, Hb., and *Loxostege similalis*, Gn., at 8 lb. per acre.

A dust of 5 per cent. chlordane was very toxic to nymphs and adults of *Psallus*, but a 1 per cent. dust was much less effective than the same concentration of DDT or a chlorinated camphene [toxaphene]. Neither concentration was as effective as a benzene-hexachloride dust containing 0·575 per cent. γ isomer. Dusts of 10 and 20 per cent. chlordane were effective against the Aphid and *Anthonomus*, but not quite so effective as corresponding concentrations of toxaphene or as 5·75 per cent. γ benzene hexachloride. The 20 per cent. dust was less effective than toxaphene against larvae of *Trichoplusia* and *Loxostege* and adults and nymphs of *Nezara*, and the results against *Heliothis* with chlordane were not nearly so promising as those with DDT or toxaphene.

Sabadilla was more effective at 20 per cent. against adults and nymphs of *Nezara* than 10 per cent. DDT, but less effective than 20 per cent. toxaphene or chlordane ; it was less effective at 10 and 5 per cent. than 10 per cent. DDT. Dusts of 20, 10, 5 and 2·5 per cent. sabadilla were fairly satisfactory against nymphs and adults of *Psallus*, but were less toxic and much slower in action than 5 per cent. DDT in sulphur. The sabadilla dusts had practically no effect on the Aphid, *Anthonomus*, *Heliothis* or *Alabama*.

The ground stems and roots of *Ryania speciosa* were rather toxic to third-instar larvae of *Heliothis* when used undiluted ; this dust was much slower in action than 5 per cent. DDT, but its effect was about the same after five days. Mixtures of 50, 25 and 12·5 per cent. of the powder in pyrophyllite were much less toxic than 5 per cent. DDT against *Heliothis*. The undiluted powder gave better results against *Nezara* than 10 per cent. DDT, but was less toxic than 20 per cent. toxaphene, chlordane or sabadilla ; it was ineffective against the Aphid at 10 and 30 lb. per acre and only moderately effective against *Anthonomus* at 32 lb. per acre.

Dusts containing hexaethyl tetraphosphate were extremely effective against the Aphid, concentrations as low as 1·25 per cent. giving good control. These dusts break down rapidly in storage, however, and mixtures had lost about half their toxicity after one day and practically all of it after three or more days, whether the diluent was pyrophyllite, celite [diatomaceous earth], sulphur or talc. Hexaethyl tetraphosphate appears to be incompatible with calcium arsenate or hydrated lime, since even freshly prepared mixtures with these materials were ineffective. Nymphs and adults of *Psallus* were readily controlled with hexaethyl tetraphosphate in pyrophyllite, 5 per cent. dusts being about as toxic as 5 per cent. DDT in sulphur, but 1 per cent. dusts less toxic. Dusts containing 5 per cent. hexaethyl tetraphosphate were ineffective against *Anthonomus* and *Heliothis*.

A micronised mixture of 25 per cent. azobenzene in fuller's earth was diluted with pyrophyllite to give weaker dusts. This compound was fairly effective against nymphs and adults of *Psallus* at concentrations of 25 and 12·5 per cent. but not very effective at 6·25 and 3·125 per cent. Azobenzene at 25 per cent. was not toxic or only slightly toxic to *Anthonomus*, *Heliothis* and the Aphid.

Two dusts, one containing 0·5 per cent. of the product known as piperonyl cyclohexenone and 0·04 per cent. pyrethrins in an unknown carrier, and the

other 0·0125 per cent. piperonyl butoxide and 0·001 per cent. pyrethrins in pyrophyllite, gave moderate control of adults and nymphs of *Psallus*, but were less effective than DDT, toxaphene or benzene hexachloride, and neither was effective against *Heliothis*, *Anthonomus*, *Nezara* or the Aphid.

Srivastava (A. S.) & Wilson (H. F.). **Benzene Hexachloride as a Fumigant and a Contact Insecticide.**—*J. econ. Ent.* **40** no. 4 pp. 569–571, 1 ref. Menasha, Wis., 1947.

The fumes from a single 0·5 gm. dose of a dust containing 5 per cent. technical BHC (benzene-hexachloride) in a bell jar of 1,400 cu. ins. capacity gave 80 per cent. mortality in 24 hours of pea Aphids [*Macrosiphum onobrychis*, Boy.] put under it 18 days later, and similar tests with other Aphids gave somewhat similar results. The dosage of γ isomer in these tests was 0·003 gm. per 1,400 cu. ins., but since samples of the α and β isomers had some fumigant effect against Aphids, the total effective dosage was estimated as 0·025 gm. In battery jars with a capacity of about 250 cu. ins. and at a temperature of 75°F., doses of 2·5 and 5 gm. BHC on paper round the outside of screen cages containing the insects gave complete kill of adults of *Blattella germanica*, L., *Ephestia kuehniella*, Zell., and *Trogoderma sternale*, Jayne, and larvae of *Malacosoma americana*, F., within four days, of larvae of *E. kuehniella* and adults of *Oryzaephilus surinamensis*, L., within seven days, and of adults of *Dermestes lardarius*, L., and *Tribolium confusum*, Duv., and larvae of *D. lardarius* and *Trogoderma sternale* within 11 days, whereas untreated insects were alive after three weeks. It appeared therefore that the fumes from technical BHC had a definite effect on insects, that some species were more resistant than others and that in some species adults were more easily killed than larvae. In a test of the residual effect, in which half-grown larvae of *M. americana* were put in a jar with BHC until they were dead, after which the BHC was removed and additional larvae put in the jars after 24 hours, the times required for complete mortality were 80, 80 and 96 hours for 10, 5 and 2·5 gm. benzene hexachloride for the first batch and 120 hours in all cases for the second. All insects were alive after seven days in empty jars or jars containing 10, 5 and 2·5 gm. DDT. In another experiment, carbon bisulphide, ethylene dichloride and carbon tetrachloride were tested alone and with the addition of relatively small amounts of BHC against *B. germanica*, *M. americana*, *T. sternale* and *Tribolium confusum* in battery jars. The addition of BHC reduced the amount of fumigant required to give complete mortality in 24 hours in every case, and in some instances the reduction was nearly 50 per cent. An experiment designed to observe the combined fumigation and contact effect of BHC by putting it in direct contact with a mass of wheat grains at 1 : 1,000 or more by weight and introducing 200 adults of *T. confusum* at the top of the container showed that the contact effect was stronger than the fumigating effect, as only when the material was well distributed through the grain was high mortality obtained in 48 hours. It is concluded that if BHC does not affect the flavour, it might be advantageously mixed with grains as they are run into storage bins at harvest time and give adequate protection up to the time of milling, since the fumes appear to remain effective for a long time in closed containers. However, further tests are necessary to determine whether it can be used on a practical basis in competition with such liquid fumigants as carbon tetrachloride, carbon bisulphide and ethylene dichloride.

Roberts (R.). **Soil Treatment to control *Blapstinus* Wireworms.**—*J. econ. Ent.* **40** no. 4 pp. 571–572. Menasha, Wis., 1947.

Much of the ground on the Experiment Station Farm at Weslaco, Texas, planted with annual crops was found in the spring of 1946 to be rather heavily

and uniformly infested by larvae of a species of *Blapstinus*. These caused severe damage to the seed and seedlings of cantaloupe melons in a plot that had been planted with watermelon the previous year and which contained an abundance of watermelon seed that had been nearly destroyed. The average infestation was two larvae per square foot, but these were concentrating in the cantaloupe hills. A small amount of 0·575 per cent. γ BHC (benzene hexachloride) was worked into the soil round the plants in six hills on 2nd March, and 51 of 60 larvae taken from them 2–4 days later died. Some of the material was dusted on small plants with cotyledons only and caused no injury to them, but BHC was later found to injure larger plants when dusted at a concentration as low as 1·5 per cent. Further tests were made with 0·575 per cent. γ BHC in Pyrax, a 25 per cent. DDT dust and a bait of 40 per cent. cryolite in finely ground dried *Citrus* pulp, worked into the soil at about 4 gm. per hill on 3rd and 4th March, when a large part of the plot was replanted. The hills averaged eight inches in diameter. Many larvae were taken on the surface of the soil, which is contrary to their normal habit, on the DDT and BHC plots, and may have been attempting to escape from the insecticide. The mortality percentages were 1·7, 83·5, 68·3 and 2·2 in untreated plots and those treated with BHC, DDT and cryolite, respectively. Germination of the cantaloupes was irregular owing to dry weather, but though BHC used at the same rate on cotton seed and maize in pots delayed germination and growth, it did not reduce the final stand, indicating that low concentrations might prove efficient against the larvae without excessive toxicity to the seedlings. A considerable increase in the number of cantaloupes surviving was obtained from the use of DDT, which possibly caused slight scorching. Although there was a substantial survival of plants in the cryolite plots, the lack of kill indicated that this bait gave little or no protection.

Brett (C. H.) & Rhoades (W. C.). **Boll Weevil Control with Chlordane, Benzene Hexachloride, and Calcium Arsenate Dusts.**—*J. econ. Ent.* **40** no. 4 pp. 572–574. Menasha, Wis., 1947.

The following is substantially the authors' summary. Field tests at Eufaula, Oklahoma, during the season of 1946 showed that talc dust containing 10 per cent. technical chlordane by weight and applied at the rate of 10 lb. per acre was about as effective against the boll weevil [*Anthonomus grandis*, Boh.] on cotton as calcium arsenate applied at 6 lb. per acre. BHC (benzene hexachloride) in a dust containing 5 per cent. γ isomer by weight applied at 10 lb. per acre, was somewhat more effective than either. The effectiveness of the control decreased as overlapping of weevil generations resulted in a daily re-establishment or increase of the population. Final yields showed about the same gain in a field in which calcium arsenate was applied a week after the appearance of the first squares and twice more at weekly intervals as in a less heavily infested one in which five applications were made throughout the season, each application being delayed until 25 per cent. or more of the squares had become infested.

Laboratory experiments showed that the susceptibility of the weevil to BHC increased as the temperature was raised, and that this was true to a less extent for chlordane. Dust containing 4 per cent. γ BHC was more toxic than dust containing 4 per cent. technical chlordane.

Hamner (A. L.). **Dusts for protecting Seed Corn from Insects.**—*J. econ. Ent.* **40** no. 4 pp. 574–575, 3 refs. Menasha, Wis., 1947.

Maize seed stored for sowing in the southern United States is difficult to protect from insect attack, particularly where both *Calandra* (*Sitophilus*)

oryzae, L., and *Sitotroga cerealella*, Ol., are major pests, and a dust treatment that would eliminate the necessity for additional control measures after one fumigation is very desirable. Investigations were therefore carried out in Mississippi to determine the effectiveness of several dusts. Small samples of maize were treated with the dusts at the rate of 1½ oz. per bushel and exposed for 32 weeks to infestations consisting primarily of *C. oryzae*, *S. cerealella* and *Plodia interpunctella*, Hb., under moisture conditions suitable for the development of the insects. Dusts containing 3 per cent. DDT in inert diluents or fungicides gave uniformly excellent control. At the end of the experiment, untreated maize had 13 per cent. undamaged kernels when it was exposed to insects and 97·6 when it was not, while the lowest average percentage of undamaged kernels given by any of the dusts containing 3 per cent. DDT was 95·3 and the loss of germination was negligible. A fairly high degree of control was obtained with 0·5, 1 and 2 per cent. dusts, but with one exception the relatively low germination showed that the lower dosages of DDT were not as uniformly effective as is desirable for protecting seed maize. Sabadilla with lime was ineffective, and none of the non-toxic materials tested (Pyrax, magnesium oxide, sulphur, borax and chalk) was of economic value. Five fungicidal dusts were tested, and all appeared to be compatible with DDT, each mixture giving excellent protection against insects without affecting germination. When the fungicides were used alone, Arasan (50 per cent. tetramethyl thiuramdisulphide) gave 85·6 per cent. undamaged kernels, which was improved to 98·3 by the addition of 3 per cent. DDT, but none of the others gave economic protection.

Chapman (A. J.), Richmond (C. A.) & Fife (L. C.). **Comparative Toxicity of Benzene Hexachloride and DDT to Thrips on Cotton and Onions.**—*J. econ. Ent.* **40** no. 4 pp. 575–576. Menasha, Wis., 1947.

Thrips tabaci, Lind., was a serious pest of cotton and onions in the Lower Rio Grande Valley of Texas during the early spring of 1946, and large areas of both crops were dusted with DDT for its control. Field tests were carried out on seedling cotton and large green onions to compare the toxicity of BHC (benzene hexachloride) and DDT to the thrips. A dust containing 50 per cent. BHC in calcium sulphate (approximately 5·75 per cent. γ isomer), further diluted with dusting sulphur to contain 0·18, 0·72, 1·43 and 2·87 per cent. γ isomer, and one of 5 per cent. DDT in sulphur were compared with a spray made by dissolving 0·4 lb. technical DDT in 0·75 U.S. pint xylene and emulsifying the solution in water to the required dilution, with Triton X-100 at 1 ml. per U.S. gal. spray as the emulsifier. Applications were made early in the morning, when the plants were usually damp with dew and the air was calm. Two applications on cotton caused a significant reduction in the thrips population 24 hours after each application in all treatments. The dusts were usually applied at about 8 lb. per acre and the sprays at 4·5 U.S. gals. per acre. The spray gave significantly better control than the DDT dust when the amount of DDT applied per acre was the same. When used at approximately 8 lb. dust per acre, 0·18 per cent. γ BHC gave about the same control as 5 per cent. DDT, and in general the reduction in population was greater as the amount of BHC per acre was increased. Within 5–6 days after treatment the thrips population had increased in all the plots, but the increase was greater in the BHC plots than in the DDT plots, and there was little or no increase in untreated plots, possibly because the cotton in them was so badly damaged that it was no longer attractive to the thrips. The cotton in the treated plots was noticeably greener and more luxuriant in growth than that in untreated ones, but there was no apparent difference in yield.

On onion, one application of 5 per cent. DDT dust at about 30 lb. per acre, 1·43 or 2·87 per cent. γ BHC at 20 lb. per acre or DDT spray at 4·8 U.S. gals. per acre gave a significant reduction in thrips population 24 hours and 5–6 days after treatment, indicating that the residues of both compounds were more toxic on large onion plants than on cotton seedlings, probably owing to greater protection from sunlight. BHC at 0·56 lb. γ isomer per acre gave at least as good control as DDT in a dust or spray at 1·47 and 0·96 lb. per acre, respectively, and dust containing 2·87 per cent. γ BHC gave significantly better control 5–6 days after treatment than dust containing 1·43 per cent. when both mixtures were applied at 20 lb. per acre. None of the treatments caused any apparent damage to cotton or onions at the dosages tested. In additional tests, BHC dust containing 5·75 per cent. γ isomer was applied six times at intervals of five days to young cotton plants from the time that they had 4–6 leaves per plant. It was applied at the rates of 8, 16 and 32 lb. per acre, the nozzle of the hand dust gun being placed directly over the plants. Light to severe scorching was evident on all the plants, the amount being greater as the amount of benzene hexachloride per acre was increased, but no scorching resulted from applications made when the plants were dry, regardless of the dosage. The numbers of bolls per plant 27 days after the last application averaged 9·2, 9·5 and 6·7 for the three rates of application, respectively, as compared with 10 for no treatment, and the numbers of squares per plant 22·7, 21·6 and 21·2, as compared with 19·8.

SIEGLER (E. H.) & BOWEN (C. V.). **Tests for Synergism in paired Mixtures of Nicotine, Nornicotine, and Anabasine.**—*J. econ. Ent.* **40** no. 4 pp. 576–577, 1 ref. Menasha, Wis., 1947.

Since nicotine and nornicotine occur together in tobacco and commercial nicotine products and anabasine and nicotine have been mixed for use as commercial insecticides, the possibility of synergistic action of these alkaloids was tested. Aqueous solutions of nicotine, nornicotine and anabasine dissolved separately at a concentration of 0·05 per cent. and paired solutions of the mixed alkaloids consisting of 0·025 per cent. of each component were tested against *Cydia* (*Carpocapsa*) *pomonella*, L., by the apple-plug method [*cf. R.A.E.*, A **23** 174]. The results confirmed the greater toxicity of nicotine [**36** 93], but failed to show any synergism in any of the three pairs of alkaloids.

DOUTT (R. L.) & FINNEY (G. L.). **Mass-culture Technique for** *Dibrachys cavus*. —*J. econ. Ent.* **40** no. 4 p. 577, 4 refs. Menasha, Wis., 1947.

A stock of *Dibrachys cavus*, Wlk., is maintained in shallow wooden boxes with tight cloth covers. Adults are introduced through a one-inch hole in the end each day in order to maintain the population of active females. Mature larvae of *Gnorimoschema operculella*, Zell., are collected in quantity from laboratory cultures by permitting them to form their cocoons in sand on cocooning plates within an electric barrier and then removing them from the cocoons by treatment with sodium-hypochlorite solution [*cf. R.A.E.*, A **34** 142; **35** 174]. These larvae are immediately immersed for two minutes in water at 155°F. containing paraffin wax with a low melting point (43–47°C. [109·4–116·6°F.]) and a blood albumin spreader, and then spread on wooden-framed cloth trays, which are put on the cloth covers of the parasite boxes and dampened. On drying, the cloth of the boxes and the cloth of the trays seal together, and the *Dibrachys* females oviposit readily through the two layers of cloth. The host larvae, although killed by the hot-water treatment and coated with paraffin wax, remain attractive to the parasites. The cloth trays containing the parasitised larvae are removed from the boxes daily and kept at 82°F. for 14 days, at the end

of which the *Dibrachys* larvae have consumed their hosts and pupated. The *Dibrachys* pupae are separated from the remaining host material by sifting through a 16-mesh wire screen.

CLANCY (D. W.) & POLLARD (H. N.). **Further Experiments in the Parasitization of Mealybugs.**—*J. econ. Ent.* **40** no. 4 pp. 578–579, 2 refs. Menasha, Wis., 1947.

The results are summarised of further tests in Virginia with various species of mealybugs as possible hosts for internal parasites of other mealybugs [*cf. R.A.E.*, A **33** 109]. Adults of both sexes of *Allotropa utilis*, Mues., an important solitary parasite of *Phenacoccus aceris*, Sign., on apple in Canada, were introduced into battery jars containing young nymphs of *Pseudococcus comstocki*, Kuw., *P. maritimus*, Ehrh., *P. citri*, Risso, *P. adonidum*, L., *Ferrisia* (*P.*) *virgata*, Ckll., and *Phenacoccus gossypii*, Tns. & Ckll., that had been reared on sprouted potatoes, but no progeny was obtained and it is assumed that the Platygasterid will not develop as a parasite of these mealybugs. Attempts to propagate *Chrysoplatycerus splendens*, How., a solitary parasite of *Pseudococcus maritimus* in California, in immature nymphs of *P. comstocki*, resulted in a rapid decline of breeding stocks, but when adult females were used as hosts, 2·9–4-fold increases (in total adults reared per parent female) were obtained, but as only 33–42 per cent. were females, work with this species was abandoned. Although *C. splendens* was reared in greater numbers from *P. maritimus*, the proportion of females was even lower.

Zarhopalus sheldoni, Ashm., another solitary parasite of *P. maritimus* in California, was propagated successfully in *P. comstocki*, particularly with large nymphs and adult females as hosts. Under optimum conditions an average increase of 5·3-fold was obtained, 55·4 per cent. of the progeny being females. Total production was further increased by using each female in several successive cages for about seven days each, and 7,622 individuals were released against *P. comstocki* in twelve apple orchards in Virginia in 1944 and 1945. Only a few adults were recovered during the seasons of release, and there is no evidence that this species has become established on *P. comstocki*. In comparative tests with its normal host, *Z. sheldoni* showed an average 13·2-fold increase, 44 per cent. of the young being females. In further tests, *Z. sheldoni* also developed readily as a parasite of *P. adonidum*, but only a few young were obtained with species of *Pseudococcus* from oak and grass roots and none from *F. virgata* and *Phenacoccus gossypii*.

Pseudaphycus mundus, Gah., an important parasite of *Pseudococcus boninsis*, Kuw. [*cf.* **36** 316], readily attacked the mealybugs offered to it, but *P. maritimus* was immune to parasitism, *P. citri* was nearly so and *P. comstocki* and *Phenacoccus gossypii* showed considerable resistance. A 19-fold increase and the highest ratio of females to males was obtained with *Pseudococcus adonidum*. As a result of these tests, breeding stocks of the parasite were sent to southern California, where *P. adonidum* has recently become a troublesome pest of *Citrus*. *Pseudaphycus mundus* also oviposited readily in *F. virgata* and a species of *Pseudococcus* from grass roots, but young were obtained only from the latter. *Hambletonia pseudococcina*, Comp., and a species of *Anagyrus*, possibly *coccidivorus*, Doz., two South American parasites of *P. brevipes*, Ckll., were tested with *P. comstocki*, *P. maritimus*, *P. adonidum*, *P. citri*, *F. virgata*, *P. sorghiellus*, Forbes, *P. dentatus*, Lobdell, *Phenacoccus gossypii*, a species of *Trionymus* from hickory and two unidentified mealybugs from grasses. *Hambletonia* attempted oviposition only in one of the species from grasses and produced no young, and *Anagyrus* gave rise to only one adult from the same species of grass mealybug, though it also oviposited in *Pseudococcus sorghiellus*, *P. dentatus* and *Trionymus*.

MEDLER (J. T.) & SCHOLL (J. M.). **Control of Insects affecting Alfalfa Seed Production in Wisconsin.**—*J. econ. Ent.* **40** no. 4 pp. 579–581, 2 refs. Menasha, Wis., 1947.

The results are given of experiments carried out in Wisconsin in 1945–46 to evaluate DDT and lime-activated sabadilla [*cf. R.A.E.*, A **34** 301] for the control of insects that affect lucerne seed production. The insecticides were applied before the plants flowered, and counts were made of *Lygus oblineatus*, Say, *Adelphocoris lineolatus*, Goeze, and *A. rapidus*, Say, the species chiefly involved, and also of *Empoasca fabae*, Harr., which is a pest of lucerne in Wisconsin. Tests on first-growth lucerne showed that dusts of 10 per cent. DDT or 2·5 per cent. DDT with 5 per cent. sabadilla in pyrophyllite and a spray of ½ lb. DDT per 100 U.S. gals. caused increases in the yield of seed. The average numbers of Mirids and leafhoppers were higher on untreated than on treated plots, with no great differences between the average numbers in the sprayed and dusted plots. One plot that was treated twice with the mixed dust in 1946 had fewer insects and a higher yield than one that was treated only once.

In tests on second-growth lucerne in 1945 with sprays applied to give dosages of 0·5, 1 and 2 lb. DDT (as a 50 per cent. wettable powder) per acre, insect counts and seed yields showed that progressively better control was obtained with higher concentrations of DDT. When dusts containing 5 per cent. DDT, 10 per cent. sabadilla or 2·5 per cent. DDT with 5 per cent. sabadilla in pyrophyllite were applied in various districts in 1946, there was much local variation, but most of the treated plots produced more seed than untreated ones. Statistical analysis of the total yields showed that the total increase for sabadilla alone was not significant while those for DDT alone and with sabadilla were significant, though the difference between them was not.

MINER (F. D.). **Life History of the Diamondback Moth.**—*J. econ. Ent.* **40** no. 4 pp. 581–583, 2 refs. Menasha, Wis., 1947.

Owing to a large increase in the cultivation of crucifers, especially mustard, turnips and cabbage, in Arkansas and the consequent probability that *Plutella maculipennis*, Curt., will become of greater importance there than in the past, studies on its life-history were carried out in a shaded greenhouse in 1945 by a technique that is described. The adults lived for an average of about seven days, and the preoviposition period averaged 2·7 days. Generally the largest number of eggs was deposited on the first day of oviposition and the rate of deposition declined steadily until death. The average and greatest numbers per female were 117·6 and 332. The ratio of males to females was 1 : 2. The egg stage lasted 2–4 days at mean temperatures of 75–80°F., and the four larval instars averaged 2·4, 1·6, 1·8 and 2·1 days on mustard at mean temperatures of 67–82°F. Small numbers of larvae were reared on various other cruciferous vegetables and showed no great difference in rate of development. The pupal stage lasted 3–8 days according to temperature (means of 66–84°F.). Maximum temperatures of 96 and 98°F. had no observable ill effect on the pupae themselves, but the resulting females were nearly sterile. It is evident that a generation could be produced in as little as 11 days, and since it is commonly recommended that no insecticide poisonous to man should be applied for the control of cabbage caterpillars within 30 days of harvest, which might permit two or more generations of *P. maculipennis* to develop, a serious outbreak could result if natural controls were temporarily inadequate.

Nagel (R. H.) & Granovsky (A. A.). **A Turntable Light Trap for taking Insects over regulated Periods.**—*J. econ. Ent.* **40** no. 4 pp. 583–586, 2 figs., 1 ref. Menasha, Wis., 1947.

The authors give details of an improved form of a multiple automatic light-trap that has already been noticed [*cf. R.A.E.*, A **23** 331]. The new trap costs considerably less and is so light and compact that it can easily be transported in the back seat of a car. It has eight collecting jars but only one opening at the top, so that all the jars except the one actually being exposed under the opening are protected from showers and there is no possibility of accidental trapping of insects in them. It was originally designed for observations on June beetles [*Lachnosterna*] in Minnesota, but has also been used in sampling the nocturnal flights of other insects, including mosquitos.

Smith (C. F.) & Veerhoff (O.). **Ethylene Dichloride Injury to Peach.**—*J. econ. Ent.* **40** no. 4 p. 588, 1 ref. Menasha, Wis., 1947.

Since ethylene dichloride used against the borer [*Aegeria exitiosa*, Say] in peach trees in North Carolina [*cf. R.A.E.*, A **31** 484 ; **34** 347] has been suspected of killing or injuring the trees there, an experiment was begun in 1942 to determine the type of injury caused by ethylene dichloride and paradichlorbenzene and the concentration at which injury would occur in the sandy soil of the main peach-growing section of the State. Two-year-old trees were treated with 4 oz. ethylene-dichloride emulsion at concentrations of 5, 10, 20, 30, 50, 70 or 90 per cent. or with ½, 1, 2 or 4 oz. paradichlorbenzene on 8th October 1942 and examined for injury on 12th December 1942 and 11th May 1943. In one case, the sand round the trees was wet before applying the 30 per cent. emulsion, and in all cases the emulsion was poured on the trunk of the tree and the tree was mounded immediately after treatment. It was found that ½ oz. paradichlorbenzene caused some brown flecking in the cambium and wood, and 1, 2 and 4 oz. caused proportionately more. In no case was the injury severe enough to cause any noticeable difference in the appearance of the foliage. Trees treated with 5–30 per cent. ethylene dichloride did not show any injury in the cambium or the wood, even when the sand was moistened before application. Trees treated with 50 per cent. ethylene dichloride showed flecking in the cambium but very little injury in the wood, and the 70 and 90 per cent. emulsions caused more distinct flecking of the cambium and some injury to the wood that had been formed the previous year. In none of the trees did the injury continue all round the trunk. The same trees were treated again on 14th October 1943 and showed results very similar to those of the previous year on examination four weeks later. When the leaves appeared in the following spring it was impossible to identify the injured trees without cutting into the bark near the base, and the flecking of the cambium was much less noticeable.

It is recommended that if the trees are heavily infested with borers (more than an average of four per tree), a 20–25 per cent. emulsion should be used on sandy soil, but that concentrations for heavy soil should not exceed 15 per cent. for trees six years old or more or 10 per cent. for those less than six years old. Enough emulsion should be applied to moisten the soil all the way round the tree ; this will be about 2 oz. for a tree one year old or 8 oz. for one six years old.

Cox (J. A.). **Control of Cherry Fruit Flies.**—*J. econ. Ent.* **40** no. 4 pp. 588–590, 3 refs. Menasha, Wis., 1947.

Both *Rhagoletis cingulata*, Lw., and *R. fausta*, O.-S., infest cherries in Erie County, Pennsylvania, the latter in very small numbers, but as the habits of

the two species are similar they are treated as one in this paper. There is a general infestation in neglected orchards, and even in those that are well cared for, careful attention to control measures is necessary to prevent an increase in infestation. In commercial orchards, a spray of 2 lb. lead arsenate per 100 U.S. gals., applied twice to the fruit and foliage during the time when most of the adults emerge, has given satisfactory control, but usually results in heavy residues on the fruit at harvest. This is generally a problem only on cherries sold as fresh fruit.

Field experiments with various insecticides were carried out in 1944–46. The emergence of the fruit-flies was timed by means of baits of 5·3 per cent. casein and 3 per cent. sodium hydroxide in wide-mouthed jars hung in the middle of the trees. The flies normally appear about 10th June, reach a maximum from 20th to 24th June and disappear about 20th July. In 1945, two applications of 0·4 lb. DDT per 100 U.S. gals. reduced the number of larvae per 100 fruits to 3·5, as compared with 25 in 1944, and one application of 0·8 lb. DDT per 100 U.S. gals. reduced it to 1·81. In 1946, two sprays of 1 lb. DDT per 100 U.S. gals. reduced infestation from 15 larvae per 100 fruits in 1945 to 0·1 per 100, indicating that for effective results DDT should be used at approximately this strength. However, large amounts of spray residue are likely to accumulate on fruit in orchards that receive two applications of DDT at this concentration, and as the residue is not readily removed by the usual washing processes, it is unlikely that DDT can be used extensively in these sprays. Two applications of 2 lb. phenothiazine with 1 lb. lead arsenate per 100 U.S. gals. gave satisfactory control of heavy infestations and were as effective as 2 lb. lead arsenate alone, but this combination is not readily adapted to the fruit-fly schedules, in which fungicides such as lime-sulphur are used. Two sprays of 3 lb. cryolite per 100 U.S. gals. gave satisfactory control in 1944 and 1946, but two of 2 lb. cryolite were not entirely satisfactory in 1945 (2·39 larvae per 100 fruits), possibly because the orchard was adjacent to unsprayed seedling cherry trees. In 1946, two applications of 2 lb. benzene hexachloride per 100 U.S. gals. reduced the number of larvae per 100 fruits from about 49 in 1945 to 3·33, which, although not sufficient, is evidence that the compound is effective against the flies. However, its disagreeable odour and taste persisted on the fruit, and at harvest the cherries were not suitable for use.

In laboratory tests with DDT, flies that were put in cages bearing the dry residue from a spray of 0·8 lb. DDT per 100 U.S. gals. all died in 20 hours, whereas others kept in an unsprayed cage lived for 5–36 days.

TURNER (N.). **Dilution of Dusts by Volume.**—*J. econ. Ent.* **40** no. 4 p. 592, 4 refs. Menasha, Wis., 1947.

In directions for mixing insecticidal dusts, the proportions are usually given by weight. When diluents of similar densities are used, the resultant mixtures have similar volumes, but when a very light diluent is used, the volume of dust containing a given dosage of poison is much increased. It has been shown that 1 lb. diatomaceous earth has the same volume as 4 lb. clay, the greater bulk of the former being due largely to lower density of individual particles, so that dilution on the basis of volume is necessary to provide an equal number of particles of these diluents per particle of toxicant.

In tests against the Mexican bean beetle [*Epilachna varivestis*, Muls.] in Connecticut in 1944, dusts of pure ground derris root (4 per cent. rotenone) in pyrophyllite, in the same proportion of diatomaceous earth by weight and in the same proportion of diatomaceous earth by volume, applied at 3 oz., 1·7 oz. and 0·5 oz. per plot, respectively, showed no substantial difference in effectiveness, although the weights of rotenone actually used were

least in the mixture of derris and diatomaceous earth by volume, indicating that this mixture was the most efficient. Studies of the relationship between pounds of dust applied per acre and concentration of toxicant have shown that lower amounts of more concentrated dusts were more efficient than higher amounts of less concentrated dust [*R.A.E.*, A **34** 310], so that the use of a small weight of a more concentrated dust diluted with diatomaceous earth should be advantageous.

BRETT (C. H.) & HODNETT (E. M.). **Chlorinated Extract of *Amorpha fruticosa*.**—*J. econ. Ent.* **40** no. 4 p. 593, 2 refs. Menasha, Wis., 1947.

Various attempts have been made to increase the toxicity of extracts of *Amorpha fruticosa* to insects [*cf. R.A.E.*, A **36** 9, 154], and the most striking effect has been obtained by chlorination. The method is described. The standard solution used for tests, which contained the chlorinated extract of 1 gm. fruits per cc., was toxic to mosquito larvae and left a deposit on wood that had a repellent and highly toxic fumigant action on flies and mosquitos [B **37** 118], but a dust prepared by impregnating 100 gm. walnut-shell flour with 100 cc. of the solution was ineffective against adults of *Melanoplus mexicanus*, Sauss.

People working with this material experienced dull headaches after about four hours and strong irritation of the eye, nasal and throat membranes for several minutes after breathing the fumes from it.

FLETCHER (R. K.), GAINES (J. C.) & OWEN (W. L.). **Insecticides for Control of Thrips on Cotton.**—*J. econ. Ent.* **40** no. 4 pp. 594–596, 6 refs. Menasha, Wis., 1947.

The results are given of experiments carried out in 1945 and 1946 on the control of thrips on seedling cotton in Texas. *Frankliniella tritici*, Fitch, was the most abundant of the species involved. In 1945, under conditions of light thrips infestation, 2–3 applications in May–June of sprays containing 0·5, 1 and 2 per cent. DDT gave better control than 3–4 in May of dusts of 3 per cent. DDT with oil, 5 or 10 per cent. DDT or a proprietary thiocyanate. The sprays seemed to be effective for longer than the dusts, probably because the latter were more easily washed off by rain, and the 0·5 per cent. DDT spray gave about as good control as the others even when applied at only 5½ U.S. gals. per acre.

In 1946, under conditions of heavy infestation, a 1 per cent. DDT spray applied at about 1 lb. DDT per acre gave better control than dusts applied at 12 oz. DDT per acre. The control was highest during the first 6–7 days after an application, but low after two weeks, owing to migration of thrips and loss of effectiveness of the materials. The spray seemed to be effective for longer than the dusts. Dust mixtures of 5 per cent. DDT in sulphur, benzene hexachloride and sulphur (2·3 per cent. γ isomer) and thiocyanate were about equally effective. Under conditions of low infestation in 1946, better control was obtained and the DDT spray was again effective for longer than the dusts.

In none of these experiments did the treatments reduce the percentages of plants showing " thrips injury " or (on the basis of figures for 1946) increase the yield, and in one test the percentage of injured plants was high although the thrips were not numerous enough to be considered injurious. It therefore

seems probable that factors other than thrips were responsible for the injury attributed to them.

DeBach (P.). **Predators, DDT, and Citrus Red Mite Populations.**—*J. econ. Ent.* **40** no. 4 pp. 598–599, 3 refs. Menasha, Wis., 1947.

The increase of phytophagous mites after applications of DDT to trees has been attributed to the elimination of predators by the insecticide. However, no detailed study has demonstrated that any species of mite is satisfactorily controlled in the field by predators, whereas it has been shown that the leaf-feeding injury by *Paratetranychus citri*, McG., and leaf age directly influence the fecundity of this species [*R.A.E.*, A **31** 244], and that increases of its population are associated with the presence of inert spray residues on the trees [**31** 101].

Although these factors have a definite influence on the population of *P. citri*, field observations and experiments by the author in California indicated that predators may also limit it. During the first half of March 1946, infested *Citrus* trees in three groves were left untreated or treated with 12·5 per cent. DDT in talc, or talc alone, both applied as a dust or spray at the rate of 2 lb. per tree. Periodical observations revealed marked differences between the numbers of mites and predators after different treatments, and final counts on 24th May showed that the numbers of mites and predators per 100 leaves were 2,302 and 9·7, respectively, on trees treated with DDT in talc, 1,896 and 32·8 on those treated with talc only and 377 and 28·8 on untreated ones. The chief predators observed were *Stethorus picipes*, Csy., *Oligota oviformis*, Csy., and *Conwentzia hageni*, Banks. It is emphasised that these data represent but a single point in a cyclical process, and from analogy with unpublished work on mealybug predators it is considered that the untreated trees were probably at the end of a population cycle with mites reduced and predators disappearing, whereas those treated with talc alone were about in the middle of a population cycle with mites beginning to decrease and predators increasing, and those treated with DDT were at the peak of mite population and the beginning of the predator population. The data indicate that predators were responsible for the low population of mites on the untreated trees and that mites were numerous on the DDT-treated trees because of the scarcity of predators, but adequate proof would depend on a series of periodic observations that demonstrated a correlation between populations of *P. citri* and predators over a period of time.

Morrill jr. (A. W.) & Otanes (F. Q.). **DDT Emulsion to control Mealybugs and Scale.**—*J. econ. Ent.* **40** no. 4 pp. 599–600, 3 refs. Menasha, Wis., 1947.

Possibly owing to the killing of their Chalcidoid parasites by heavy applications of DDT in oil from aircraft against flies and mosquitos during and after the war, the populations of Coccids in and near Manila, in the Philippines, have increased considerably and some species that were fairly rare before the war have caused serious injury. The main species involved are *Asterolecanium bambusae*, Boisd., and *Coccus* sp. on bamboo, *Saissetia coffeae*, Wlk. (*hemisphaerica*, Targ.), *S. nigra*, Nietn., and *Lepidosaphes rubrovittatus*, Ckll., on *Hibiscus*, and species of *Pseudococcus* and a species that appeared to be *Ferrisia virgata*, Ckll., on mango, papaya, tobacco, cotton, breadfruit [*Artocarpus communis*], *Hibiscus*, *Croton*, palm and poinsettia [*Euphorbia pulcherrima*]. *Phenacoccus* (*Puto*) *spinosus*, Rob., was found on mango, and what appeared to be a species of *Drosicha* caused heavy drop of fruit from breadfruit trees in Mountain Province. *Pulvinaria polygonata*, Ckll., has become

unusually injurious to fruit trees, particularly caimito [*Chrysophyllum cainito*] and mango, *Parlatoria ziziphus*, Lucas, to several varieties of *Citrus*, and *Lepidosaphes* sp. to mango.

On 10th April 1947, a spray containing 5 per cent. DDT, made from an emulsion concentrate of DDT, xylene and Triton X–100 [25 : 65 : 10], was applied heavily to infested plants in an area about 12 miles north-east of Manila. Two days later, all scale insects and an average of 83 per cent. of the mealybugs on treated plants were dead. Parasitism by Chalcidoids on untreated branches was found to be 1–15 per cent. A second application to plants showing partial infestation by mealybugs gave a complete kill, and no scorching was caused on bamboo, *Hibiscus* or *Croton*. At the same time, the spray gave complete control of mealybugs and *Lepidosaphes* on mango, but caused slight to moderately serious scorching of the plants, and two applications at a concentration of 2·5 per cent. gave good control on papaya, palm, mango, mimosa and breadfruit without scorching. There was no appreciable residual effect, possibly owing to the heavy rains that occur occasionally even during the dry season. Untreated plants provided a reservoir of infestation, and mealybug populations began to increase 2–4 weeks after treatment. This reinfestation was assisted by ants of the genus *Solenopsis*, principally *S. geminata*, F., which disappeared from the plants for 2–4 weeks after treatment and then reappeared.

HANSEN (J. W.). **Hexaethyl Tetraphosphate.**—*J. econ. Ent.* **40** no. 4 p. 600, 1 ref. Menasha, Wis., 1947.

The material prepared by the reaction of triethyl phosphate and phosphorous oxychloride and known as hexaethyl tetraphosphate or HETP [*cf. R.A.E.*, A **36** 228; **37** 42, 43] does not exist in this form but is a fortuitous mixture of organic phosphates that has an average molecular weight and combustion analysis percentages agreeing with the assigned formula. Although reported to be undistillable, it can be separated into several inactive fractions and one active fraction by the use of the proper distillation techniques. This has been confirmed over a period of a year on a large number of samples.

Chemical analysis of these fractions has shown that the active agent is a tetraethyl phosphate and probably tetraethyl peroxydiphosphate [tetraethyl pyrophosphate]. The inactive fractions are mixtures of simple and complex ethyl phosphates and have negligible toxicity. There are no trustworthy chemical methods of determining the content of tetraethyl phosphate in the crude products. Tetraethyl phosphate is a stable, colourless liquid that can be repeatedly distilled without change or appreciable loss. It hydrolyses readily in water and has the characteristic behaviour of the crude HETP from which it was obtained. Its toxicity, as determined on mice, rats and a wide variety of insects, is 5–10 times that of the original material. The only useful methods of analysis known are distillation and bio-assay, by which the tetraethyl-phosphate content of most commercial samples of HETP has been found to be 10–20 per cent., though a few materials tested recently have contained 30 per cent. or more. Bio-assay and distillation results have always been in close agreement with each other, indicating that the tetraethyl phosphate is present as a separate material and does not arise by decomposition of a larger molecule. Based on bio-assay, the recovery of tetraethyl phosphate from the crude material is between 90 and 95 per cent., the loss presumably being due to a slight amount of decomposition.

Study of a large number of phosphate compounds has led to the hypothesis that the breakdown product formed in the body that is responsible for the toxic action is diethyl phosphoric acid. This is based on the observation that only those phosphate esters having two alkyl groups per phosphorous radical are toxic, whereas mono- and trialkyl compounds are relatively non-toxic. The

mechanism of action may be an interference with a phosphate enzyme system similar to adenosine triphosphate. In these systems, each phosphorous radical is connected to other groups by two ester linkages. A monoalkyl phosphate with two available acid groups and a trialkyl phosphate with none could be expected to have little effect, whereas a dialkyl phosphate with only one available acid group might react so as to break the phosphate chain and inactivate the enzyme. The slight toxicity of the mono- and trialkyl phosphates can readily be explained by a tendency of the alkyl groups to shift or hydrolyse, forming small amounts of the dialkyl compound.

Gaines (R. C.), Young (M. T.) & Smith (G. L.). **Calcium Arsenate and Nicotine to control Boll Weevil and Cotton Aphid, 1939–1946.**—*J. econ. Ent.* **40** no. 4 pp. 600–603, 6 refs. Menasha, Wis., 1947.

Three methods of using nicotine against *Aphis gossypii*, Glov., on cotton when calcium arsenate is applied against *Anthonomus grandis*, Boh., have been successfully employed in Louisiana during the last eight years, and in this paper the authors give the available information on the use of the two insecticides for combined control. The following is substantially their summary. The use of calcium arsenate dust containing 1 per cent. nicotine in all applications, alternate applications of calcium arsenate alone and with 2 per cent. nicotine, and calcium arsenate dust applied alone, with separate applications of a 3 per cent. nicotine dust when they were needed, were all equally effective for the control of the weevil and the Aphid. With the exception of some new materials tested in 1946, nicotine from nicotine sulphate or other sources appeared to be equally effective against the Aphid when mixed with calcium arsenate. Applications of mixtures of calcium arsenate and nicotine early in the morning or late in the afternoon gave significantly higher yields than calcium arsenate alone or no treatment, the late applications being slightly the more effective. Control of the Aphid by the addition of nicotine to the calcium-arsenate dusts applied against the weevil resulted in an average increase in yield of 224 lb. seed cotton per acre, which was significant, in 138 replications in 1939–46 [*cf. R.A.E.*, A **31** 187 ; **34** 311, etc.].

Hoerner (J. L.) & Edmundson (W. C.). **DDT and other Treatments for the Control of Onion Thrips.**—*J. econ. Ent.* **40** no. 4 pp. 603–605. Menasha, Wis., 1947.

For many years growers of onions and onion seed in Colorado have suffered considerable losses because of injury by *Thrips tabaci*, Lind. The Sweet Spanish variety is somewhat resistant to thrips injury, but the susceptible variety Mountain Danvers is grown for commercial use in western Colorado, and tests of some new insecticides for thrips control on it were begun in 1945. Five applications of spray or dust were made at weekly intervals from 6th July, and the onions were harvested and weighed on 6th and 7th September. The sprays were applied at about 150 U.S. gals. per acre and the dusts at about 40 lb. Counts showed that all treatments reduced the numbers of thrips. Emulsions containing 0·5 lb. DDT per 100 U.S. gals. gave better control than dusts containing 3 or 5 per cent. DDT, and all the DDT treatments were better than sprays of 2 lb. tartar emetic or 1 U.S. quart nicotine sulphate, each with 4 lb. white sugar, per 100 U.S. gals. water. Plants that were sprayed or dusted with DDT showed less thrips injury and appeared more vigorous than those that were untreated or sprayed with tartar emetic or nicotine sulphate, and yields were significantly greater on plots sprayed or dusted with DDT than on those that were untreated or sprayed with nicotine sulphate. Tartar emetic also significantly increased the yield but was significantly inferior to DDT in

all but one case. In 1946, three applications of 5 per cent. DDT dust or a suspension spray of 1 lb. DDT per 100 U.S. gals. at fortnightly intervals from 11th July or five applications at weekly intervals from the same date of the nicotine-sulphate spray, the DDT suspension, an emulsion spray of 0·5 lb. DDT per 100 U.S. gals., a spray of 1 lb. wettable benzene hexachloride (5 per cent. γ isomer) per 100 U.S. gals. or 5 per cent. DDT dust, all significantly reduced the thrips population. Yields were significantly increased by all treatments except nicotine, but the differences between weekly and fortnightly applications of the same materials were not significant. Five applications of the benzene-hexachloride spray did not reduce the thrips population so much as three of the DDT dust but gave the same yield. Three or five applications of the water suspension of DDT and five of the DDT dust gave the highest yields.

Brown (A. W. A.). **Control of *Camnula pellucida* with DNOC Emulsion from Aircraft.**—*J. econ. Ent.* **40** no. 4 p. 606, 1 ref. Menasha, Wis., 1947.

On 21st June 1946, between 6.40 and 6.55 p.m., an emulsion spray of 40 lb. dinitro-ortho-cresol dissolved in 100 lb. xylene with 8 lb. Triton X–100 and made up to 200 gals. with water was applied by aeroplane in three emission runs over a one-mile stretch of prairie road in south-eastern Saskatchewan for the control of a variable infestation of *Camnula pellucida*, Scud. [*cf. R.A.E.*, A **36** 99]. The roadsides were sown with crested wheatgrass [*Agropyrum cristatum*]. The wind was blowing at 3–5 miles per hour and the aircraft flew parallel with the road at a height of about 80 ft. and a speed of 210 miles per hour, the first two tracks being 35 yards upwind and the last 55 yards upwind. A total of 32 lb. dinitrocresol was used. The deposited spray formed a continuous swathe 75 yards wide and the coverage was remarkably even. Counts of dead grasshoppers gave an average of only 2·9 per square yard, of which 35 per cent. were *Melanoplus* spp., but probably some of the *Camnula* were not found. The reduction in population of living grasshoppers was about 75 per cent. The spray caused no appreciable damage to the grass; it scorched wheat in the field adjoining the road, but examination of the heads five weeks later indicated that the crop had probably not been damaged. The weeds in the crop and the foliage of *Caragana* and box-elder [*Acer negundo*] were severely scorched.

Brown (A. W. A.). **Control of *Melanoplus mexicanus* from Aircraft with Oil Bait containing Chlordane.**—*J. econ. Ent.* **40** no. 4 p. 607. Menasha, Wis., 1947.

The bait used in the experiment described was made by dissolving 12 lb. technical chlordane in 55 lb. Pale Base Oil 100 and spraying it on 300 lb. of a mixture of bran and sawdust (1 : 2) in a cement mixer. It was applied from a light aeroplane flying at 115 miles per hour at a height of 100 feet for the control of a moderate infestation of adults of *Melanoplus mexicanus mexicanus*, Sauss., in summer fallow covered with Russian thistle [*Salsola*], pigweed, and self-sown wheat in Alberta; 220 lb. bait was expended in each of four emission runs over a field one mile long and 130 yards wide between 5.45 and 6.15 p.m. on 11th September 1946. The wind velocity was 6–8 miles per hour, and the first flight was made 20 yards upwind of the upwind margin of the field, the second and fourth 25 yards downwind of it and the third 70 yards downwind of it. The coverage of the bait was even except in one small area, and an average of 0·61 lb. chlordane per acre was released and 0·44 lb. deposited. The average percentage reduction in grasshopper population was 57 on the day after application, 78 two days after, and 91–98 six days after, when nearly half

the survivors were confined to one edge of the field where bait had not been applied so as to form a barrier outside the field. The estimated population in an untreated field fell by 30 per cent. during this period.

BEAMENT (J. W. L.). **The Penetration of Insect Egg-shells. II.—The Properties and Permeability of sub-chorial Membranes during Development of** *Rhodnius prolixus*, **Stål.**—*Bull. ent. Res.* **39** pt. 4 pp. 467–488, 9 figs., 27 refs. London, 1949.

The following is virtually the author's summary of further investigations of the factors influencing the penetration of liquids into the eggs of *Rhodnius prolixus*, Stål [*cf. R.A.E.*, A **37** 110]. The chemistry and permeability of the membranes that are added to the inner surface of the chorion during development were studied. A true fertilisation membrane is produced immediately before oviposition when the egg is fertilised. It is attached to the inner surface of the primary wax layer [*loc. cit.*] and recessed into the micropylar region, and it covers the whole inner surface of the shell. The membrane is very thin when first formed. It is colourless, comparatively resistant to solvents and apparently composed of "vulcanised protein", in which cystine bonds are present in the protein chains. It is semi-permeable to salt solutions, but made very permeable to small molecules when immersed in absolute alcohols. In the first five days of incubation, further material is added to the fertilisation membrane. Over the main part of the shell and cap, this does not cause a great increase in the thickness of the membrane. The added material is probably proteinaceous, with tanning and vulcanising substances, and it is mostly a product of the serosa. Opposite the inner openings of the micropyles, material is accumulated at a much greater rate and by the sixth day of incubation the membrane may be 15 microns thick. The inner surface of the egg-shell thus becomes a uniformly ellipsoidal body. The thickened material is termed the epembryonic ring. At about the sixth day of incubation, shortly before blastokinesis, the membrane is partially impregnated with a wax of high melting point. This raises the transition point in the water-loss/temperature curve of the egg from 42·5 to 68°C. [108·5 to 154·4°F.]. Evidence is against this material being arranged as a second wax layer on the inner surface of the membrane. No further changes were detected until the 13th day, when the innermost parts of the membranes are broken down by the embryo. On the day before eclosion, the embryo is surrounded by a liquid containing emulsified wax and proteinaceous material. The properties of the membranes return towards those of the one-day-old egg, but do not attain them; the egg hatches on the 16th day. The changes in the membranes produce considerable changes in the apparent toxicity of ovicidal liquids, experiments with which are recorded. In general, the egg becomes more resistant to lipophiles, such as chloroform, ethyl alcohol and acetone, over the first six days and less resistant afterwards, owing to the wax impregnation. The resistance to hydrophiles, such as acetic and formic acids, increases during development owing to the epembryonic layer and secondary wax, but decreases when the membranes are broken down just before eclosion.

KAPUR (A. P.). **On the Indian Species of** *Rodolia* **Mulsant (Coleoptera-Coccinellidae).**—*Bull. ent. Res.* **39** pt. 4 pp. 531–538, 21 figs., 10 refs. London, 1949.

This revision of the Indian species of *Rodolia* is based mainly on material collected in connection with a campaign against *Icerya purchasi*, Mask., in South India [*cf. R.A.E.*, A **37** 27] and specimens in the British Museum (Natural History). It comprises a description of the genus, for which

R. ruficollis, Muls., is retained as the genotype, a key to the nine species recognised, including three new ones, and descriptions of the adults and distribution records of all except the introduced *R. cardinalis*, Muls. The new species are *R. amabilis*, *R. netara*, and *R. minima*, all of which were taken feeding on *I. purchasi* in South India, as also was *R. breviuscula*, Weise.

PARNELL (F. R.), KING (H. E.) & RUSTON (D. F.). **Jassid Resistance and Hairiness of the Cotton Plant.**—*Bull. ent. Res.* **39** pt. 4 pp. 539–575, 10 figs., 16 refs. London, 1949.

The following is based on the authors' summary of investigations at Barberton, South Africa, on the relation between the resistance of cotton plants to attack by *Empoasca facialis*, Jac., and hairiness of the leaves [*cf. R.A.E.*, A **34** 166; **35** 339]. A wide range of native and imported plant material was studied and was found to show a continuous range between full susceptibility and very high resistance. In general, relative susceptibility as gauged by visual assessment of symptoms corresponded closely with relative infestation, determined by counts of nymphs. In fully grown plants, the relative susceptibility of varieties was substantially constant under varying levels of exposure to infestation. The number, nature and distribution of the hairs varied widely on different plants. A method of expressing hairiness numerically, taking into account both the length and the density of the hairs, was devised and is described. A close and consistent relation was found between degree of hairiness of the under surface of the leaf and degree of resistance to the Jassid. Without exception, and unlike Indian experience with *E. devastans*, Dist. [*cf.* **29** 517], all thoroughly hairy types were highly resistant and all non-hairy types fully susceptible. Intermediate degrees of hairiness were associated with intermediate degrees of resistance. This relationship occurs among varieties and among plants within varieties of *Gossypium hirsutum*, among plants of *G. barbadense* and among the segregated progenies of hybrids between these species.

The hairiness of resistant strains of cotton develops gradually with the growth of the plant, the first few leaves on the seedlings being virtually non-hairy. This lack of hairiness in the early stages of growth is associated with a lack of resistance. Hairiness and resistance develop concurrently. It is concluded that hairiness of the leaf confers resistance to the Jassid, probably through its effect on oviposition [*cf.* **33** 362], and that degree of leaf hairiness, measured in an appropriate manner, is a thoroughly reliable guide to degree of resistance. Length of hairs is shown to be of prime importance, and high densities without adequate length are ineffective. The relative importance of hairs on lamina and midrib [*cf.* **33** 362] was not conclusively determined. Both influence resistance, but a high degree of midrib hairiness is not essential if the lamina is hairy. Hairs on stem and petiole are shown to be of very little direct importance.

CLARK (L. R.). **An ecological Study of the Australian Plague Locust (*Chortoicetes terminifera* Walk.) in the Bogan-Macquarie Outbreak Area, N.S.W.**—*Bull. Coun. sci. industr. Res. Aust.* no. 226, 71 pp., 3 pls., 13 figs., 19 refs. Melbourne, 1947.

The following is based on the author's summary. An intensive field study of *Chortoicetes terminifera*. Wlk., in the Bogan-Macquarie outbreak area, together with less detailed observations in the Warrumbungles outbreak area, both in New South Wales, led to the conclusion that swarming originates in well-defined outbreak centres [*cf. R.A.E.*, A **35** 133]. An outbreak centre is characterised by the presence in combination of a food-shelter habitat that is most favourable for the survival of older hoppers and adults, comprises a patchwork of tall, tussocky vegetation and low cover, and is most frequently

developed on heavy self-mulching soils, and an oviposition habitat consisting of a patchwork of bare, compact and predominantly low cover, which is most frequently developed on lighter, more compact soils [**31** 46; **35** 134]. Such a combination is commonest along the boundaries between light and heavy soils, where the change from one kind of soil to the other is abrupt, and most outbreak centres probably occur in such situations. It was observed, however, that under prolonged favourable conditions some areas of compact soil apparently give rise to swarms by the temporary development of food-shelter habitats around persistent oviposition habitats, which maintain their favourable characteristics as a result of soil erosion.

A detailed quantitative study of population numbers and pasture and soil conditions was made near Trangie on series of observation zones. The favourableness of these zones to adults and old hoppers was measured by an index based on the ratio of their populations at a late stage of the life-cycle to that at an earlier one. The late stage selected was three weeks after most locusts had become adult, and the earlier one was the fourth instar, before which little migration occurred. This ratio includes differing immigration effects, which could not be assessed satisfactorily, but in view of the amount of data available for analysis, it was considered that it would indicate the type of vegetation most favourable to adults and old nymphs, for which general observation indicated similar habitat requirements. Favourableness was found to be correlated positively with amount of green food, amount of shelter vegetation, and percentage area of habitat covered by plant growth. The existence of an optimum range in amount of shelter vegetation was established. Over a certain range of differences in amount of shelter vegetation and green food, the latter is the dominant factor, and outside it, shelter is dominant, but the data were not adequate for the precise determination of the limits within which either factor is dominant.

Preferences for oviposition sites were measured by using as an index the ratio of the zonal ovipositing population of one generation to the hatching population of the next. Preference was found to be correlated positively with the amount of bare ground and low plant cover, and negatively with the amount of tall cover. The greatest preference was for sites with approximately equal amounts of bare ground and low cover, where the soil type was similar. Evidence was obtained to suggest the existence of a range of soil compactness preferred for oviposition. Soils possessing a compact surface throughout were preferred to self-mulching types in which compact soil is scarce or absent.

Bioclimatographs using Key's curve of limiting conditions [**30** 421] were drawn for three locust seasons by plotting mean monthly temperature against mean Meyer ratio. This curve was developed from data on swarming populations, and discrepancies were found when an attempt was made to fit data on non-swarming populations with it. Some were associated with the fact that the area contained habitats that remain favourable under all conditions except prolonged drought. However, the upper moisture limit of the curve is too low and the lower moisture limit apparently a little high for the regions studied. Population data for active stages of the life-cycle showed the overriding importance of the state of the pasture on developmental processes, which is greater than that of macroclimatic conditions.

Observations on locust behaviour demonstrated the importance of temperature and wind on the daily behaviour régime. When thermometers with blackened bulbs were used, a strong indication was obtained of the existence of a temperature preferendum in the vicinity of 42°C. (107·6°F.) for adults. Temperatures above 45°C. (113°F.) appeared to be unfavourably high for adults and hoppers, which avoided situations in which they occurred. Light and humidity were relatively unimportant. Of the factors influencing movement, food is considered to operate only in that the locusts leave places where there

is none. Temperature and wind both influenced movement, and kinetic responses to them appear to be of major importance. In the food-shelter habitat, a mosaic of very different microclimates is developed within a limited area, and a small amount of wandering enables locusts to escape from situations that have become unfavourable to favourable ones. Because of the lack of shelter vegetation, areas resembling oviposition habitats have a more uniform microclimate so that large stretches become unfavourable at the same time, which stimulates the locusts to wander until favourable conditions are again encountered. The much greater amount of wandering in such areas than in areas of food-shelter habitats results in concentration in the latter and is probably its most important cause, aided by the visual attractiveness of conspicuous vegetation. As the locusts increase in size, shelter vegetation becomes increasingly important, the low cover of the oviposition habitat tending to become more and more inadequate for protecting them from extremes of solar radiation, wind and other factors. *C. terminifera* shows a preference for food in the green succulent condition ; when all the plants available for food were green, a marked preference was shown for grasses.

During the observation period, endoparasites were scarce and exerted little influence on locust numbers. The only two observed were *Trichopsidea oestracea*, Westw., and an unidentified Sarcophagid. The ectoparasitic mites, *Leptus* sp. and *Podapolipus grassii*, Berl., were sometimes numerous, but high individual infestations did not appear to inconvenience the hosts. Various predators were recorded, of which birds and wolf spiders (*Lycosa* spp.) appeared by far the most important. Neither exerted anything like the same effect on population numbers as rainfall, which in this area is the major variable governing food-supply and shelter and consequently intensity of competition between locusts.

Clark (L. R.). **Ecological Observations on the Small Plague Grasshopper, *Austroicetes cruciata* (Sauss.), in the Trangie District, central western New South Wales.**—*Bull. Coun. sci. industr. Res. Aust.* no. 228, 26 pp., 14 refs. Melbourne, 1947.

The following is substantially the author's summary. During 1939–46, some aspects of the ecology of *Austroicetes cruciata*, Sauss., were studied near Trangie, New South Wales. This species occurs in areas of the *Eucalyptus populifolia* and *Callitris glauca* association, where destruction of timber and land use have markedly altered the original communities. It is rare except in the vicinity of areas of compact soil, for which the ovipositing females show a greater preference than do those of *Chortoicetes terminifera*, Wlk. [see preceding abstract]. Evidence, partly quantitative, indicates that the favourableness of habitats to adults and older nymphs is correlated positively with the amount of green food and cover, and that sites with much bare ground are preferred for oviposition. The habitats most favourable for all stages contain a patchwork of small areas of little cover and much bare ground, which are preferred for oviposition, and one of little bare ground and much cover, which functions as a food-shelter habitat [*cf. loc. cit.*]. In the latter areas, some of the cover may be relatively tall and dense, but excessive height and denseness are unfavourable. For the most favourable habitat conditions, the food-shelter and oviposition habitats need to be closer together than in the case of *C. terminifera*, since *A. cruciata* has poorer powers of migration.

A. cruciata is of only minor economic importance in the Trangie area, because on the soil types favourable to the species, which occupy about 60 per cent. of the area, favourable habitats are limited by the development of pastures, which apparently provide micro-climatic conditions unsuitable for the development of large numbers. In years in which the winter and spring rains are

normal or above normal, such pastures develop over much of the total area of favourable soil, particularly in lightly grazed areas. Only in years in which rainfall from late autumn to spring is lower than normal is the pasture growth sufficiently limited by normal grazing to ensure that much of the favourable soil area becomes favourable to the active stages. However, very dry springs are unfavourable, a certain amount of rainfall being necessary to maintain adequate foci and shelter. The available evidence suggests that conditions too moist for the eggs seldom occur and that periods of drought sufficient to kill large numbers of eggs are very rare, being less frequent than in the South Australian grasshopper belt owing to the much higher and more reliable summer rainfall. Summer soil temperatures appear to be usually high enough to cause some mortality of eggs, but it is not known if this factor is ever responsible for high mortalities. The isopleths indicated by Andrewartha as the climatic limits favourable to swarming [**34** 124] have no significance for the Trangie area, the latitude of which is 32° S. The bionomics and food-preferences of *A. cruciata* were found to be essentially similar to those observed in South Australia [**32** 244 ; **34** 124]. The nymphal stage, however, was relatively short (under five weeks), probably because temperatures were higher than normal for the Trangie area and thus also higher than in the South Australian grasshopper belt.

Carne (P. B.). **Experiments in the Use of DDT against the Pasture Cockchafer, *Aphodius howitti* Hope.**—*J. Coun. sci. industr. Res. Aust.* **21** no. 1 pp. 1–6, 1 pl., 1 fig., 4 refs. Melbourne, 1948.

A fairly heavy infestation of *Aphodius howitti*, Hope, was found in sown pastures a few miles north-east of Canberra in June, 1946, and a test of DDT for the control of this Aphodiid was made in plots in a pasture sown in May 1942 with a mixture of *Phalaris tuberosa*, lucerne and subterranean clover [*Trifolium subterraneum*]. The soil was a greyish-brown clay loam. In July 1946, the numbers of Aphodiid and Melolonthid larvae in a small quadrat of each plot were counted by sieving the top six inches of soil, and a dust containing 2 per cent. p,p'DDT in talc was applied to the surface at the rate of 166 lb. per acre on 29th August. The populations were determined in the same manner in another small area on each plot between 15th and 29th October, and rough population surveys, based on the presence or absence of the casts thrown up by the larvae, were made on treated and untreated plots in May and July 1947 to determine the possibility of a residual effect.

The Melolonthid population showed a general decrease in both treated and untreated plots between the first two counts, the DDT having no effect, and was much higher in July 1947 ; although it was somewhat higher in untreated than in treated plots at that time, no effect of the DDT can be inferred. Population counts indicated approximately 20 per cent. control of *Aphodius* by October 1946, but this is not considered significant. The larvae had remained inactive from before the date of dusting until the day before the beginning of the October count, owing to drought conditions. Comparison of *Aphodius* populations in October 1946 and July 1947 showed some reduction in untreated plots but almost complete control in treated ones, indicating that the DDT had persisted on or in the soil for at least 6–8 months and prevented reinfestation during 1947. The adults had apparently entered the treated soil, and it is unlikely that the DDT inhibited oviposition or destroyed the eggs, since Melolonthids produced many offspring in both treated and untreated plots. It is therefore probable that it killed the young larvae by contact or after ingestion of soil when they first burrowed to the surface to feed in April 1947. The dosage was probably more than was necessary to give satisfactory practical results, as field observations suggest that *Aphodius* causes negligible damage

below a density of 20–25 per sq. ft. and really serious damage only when in excess of 150–200 per sq. ft. The persistence of the DDT would permit application of the dust at a convenient time, and it is possible that the dusted areas might remain free from infestation for more than a year.

NORRIS (K. R.). **Seasonal Severity of the Attack of the Red-legged Earth Mite (*Halotydeus destructor*) on Subterranean Clover.**—*J. Coun. sci. industr. Res. Aust.* **21** no. 1 pp. 7–15, 5 refs. Melbourne, 1948.

In further investigations on the importance of *Halotydeus destructor*, Tucker, in destroying pastures of subterranean clover [*Trifolium subterraneum*] in Western Australia [*cf. R.A.E.*, A **34** 162], attempts were made to determine the time of year at which the most critical damage is done. A selected area was sown with subterranean clover in April 1941, and seven plots treated once only with a bait of sodium fluoride, cane sugar and cereal chaff [*cf.* **32** 262], at about the middle of each of the seven months of the season during which the mite is active (May–November), were compared with plots treated on these dates and later as often as was necessary to keep infestation to a minimum and with others kept free of mites throughout the season or not protected at all.

Several small mites were found in favourable places near the plots on 25th April, and by 29th April general hatching of the aestivating eggs had occurred. Small seedlings of capeweed (*Cryptostemma calendulaceum*) were present a week or so before this date and served as food for the young mites. Germination of subterranean clover began by 29th April, and slight damage could be seen on some of the seedlings within a few days. On the untreated plots, the mite population was large and caused severe damage to the clover seedlings in the second week in May. It had dwindled considerably by early June, but was high again from the first week in July, when the next generation appeared, until the middle of October. Very few mites were present by the end of October, and none could be found after the first week in November.

On plots that were treated repeatedly, mites were never numerous enough to inflict visible damage on new growth. Plots kept free from mites gave the highest yield, and those treated from the middle of May gave yields intermediate between these and plots treated from mid-June onwards. The kill was good on all plots treated once only, but on many of them the survivors produced a population at least equal to that on untreated plots in less than two months. Observations on growth and yield showed that the greatest check to the growth of the plants was inflicted during the first few weeks after germination. A practically rainless period from 6th to 29th May probably accentuated the effect of mite attack considerably, but some damage occurred before this, when rainfall was adequate. Such long periods of drought following the germination of subterranean clover occur frequently enough in the drier areas to be a serious hindrance to the establishment and maintenance of the pastures, but the importance of rainless periods after the normal hatching time of *Halotydeus* would be reduced if the mite could be controlled. By the middle of June, the plants no longer benefited from destruction of the mites, probably owing to their domination by capeweed at this stage. They were able to compete successfully with this species if freed from mite attack early in the season.

It is clear that *Halotydeus* must be controlled as soon as possible after it hatches in the autumn, when the clover is in the greatest need of protection and the mites are delicate and have laid no eggs. To achieve such early control with non-persistent acaricides, the time of application must be carefully determined, which is difficult on account of the smallness of the young mites. The cost of such a treatment is excessive and the mite population has such great powers of recuperation that the expense would be at least annual. In view of the toxicity of DDT to the mite [*cf.* **35** 158; **36** 309] and its known

persistency, it might possibly be used to give effective control. Persistence for little more than a week would ensure a lethal concentration after the hatching of all the eggs and the resumption of activity by mites that were moulting at the time of application. If it were persistent enough it might well be combined with the routine top-dressing of superphosphate, which is generally applied before the autumn rains.

Tomatoes. Cultivation, Diseases and Pests.—*Bull. Minist. Agric.* no. 77 (revd.), iv+67 pp., 4 pls., 2 figs., 14 refs. London, H.M.S.O., 1948. Price 2*s*.

In this edition of a bulletin on the cultivation of tomatos in Britain [*R.A.E.*, A **31** 178, etc.], the section dealing with pests in glasshouses (pp. 50–60) has been revised, chiefly to bring the control recommendations up to date. It is stated in the new information that dusts and sprays of DDT against the larvae have largely superseded lead-arsenate sprays and moth-traps for the control of *Diataraxia* (*Polia*) *oleracea*, L. Seedlings and plants less than 4 ft. high may be injured by sprays and should therefore be dusted with 5 per cent. DDT applied lightly to the upper surface of the leaves at the rate of 15–20 lb. per acre ; one application should be made in the propagating house and one a week after planting out. Older plants that become infested should be sprayed once with a suspension or emulsified solution at a dilution of 0·02 per cent. actual DDT. The residues from suspensions are believed to be more persistent than those from emulsions. DDT is toxic to *Encarsia formosa*, Gah., the parasite of *Trialeurodes vaporariorum*, Westw.

The first record of *Liriomyza strigata*, Mg. [**35** 327] attacking seedlings in propagating houses was in 1940. Seedlings infested by it give rise to weak and stunted plants, but are seldom killed. The larvae usually pupate in the soil, but in summer many pupae are formed on the leaves, from which they readily fall to the ground. Recommended control measures comprise steam sterilisation of the soil, especially in propagating houses, to destroy the overwintering pupae, and a light application of a dust containing 5 per cent. DDT to the cotyledons, to prevent oviposition, and to the surface of the soil beneath the staging. The removal of mined leaves is not recommended.

Delanoue (P.). **Un parasite nouveau de l'abricotier en Tunisie : *Stenopterus ater* Lin.**—*Bull. Serv. bot. agron. Tunisie* no. 4, 8 pp., 5 figs., 3 refs. Tunis, 1946.

Injury to apricot trees, consisting of withering of the leaves and drying of the wood on one or more branches, which has been observed for some years in Tunis, was apparently caused by *Stenopterus ater*, L. The larvae, pupae and adults of this Cerambycid are described. It appears to have one generation a year ; the adults emerge from the end of April to the beginning of June, and the females oviposit on the young branches of healthy trees. The larvae bore in the wood and apparently prevent the transmission of sufficient sap when the fruit has set, but the future importance of the insect cannot be determined as injury has appeared only sporadically on trees 16–25 years old.

Chrysobothris affinis subsp. *heliophila*, Abeille, was found in the same branches as *S. ater* in increasing numbers in 1942–45. This Buprestid, which has hitherto been considered of secondary importance, appeared to attack healthy trees.

Dahms (R. G.). **Effect of different Varieties and Ages of Sorghum on the Biology of the Chinch Bug.**—*J. agric. Res.* **76** no. 12 pp. 271–288, 3 figs., 14 refs. Washington, D.C., 1948.

The following is substantially the author's summary of studies in Oklahoma during 1936 and 1937 on the effect of different varieties of sorghum on *Blissus*

leucopterus, Say [*cf. R.A.E.*, A **26** 63], those tested being representative of the milos, feteritas, kafirs and sorgos. In general, under field conditions the kafirs and sorgos are rather resistant, the milos very susceptible, and the feteritas susceptible. A study of the effect of seedling plants of nine varieties on the biology of the bug showed that females feeding on Dwarf Yellow milo laid more eggs than those feeding on any of the other varieties. In the order of their increasingly detrimental effect on the fecundity of the bug came Wheatland (a cross between kafir and Dwarf Yellow milo), Honey sorgo, Blackhull kafir, Sharon kafir, a cross between Kansas Orange sorgo and Dwarf Yellow milo, Atlas sorgo, feterita and Kansas Orange sorgo.

Under laboratory conditions, the adults preferred susceptible to resistant varieties. The latter showed the greatest tolerance to a uniform infestation by the adults. There was a marked difference in the length of life of females confined with different varieties, but it was not always correlated with the total number of eggs laid. The females lived longest on Wheatland and died soonest on Kansas Orange sorgo. Nymphs reared on the susceptible varieties were larger than those reared on the resistant ones. There were some differences in the rate of development of nymphs on the several varieties; they developed significantly faster on the susceptible ones. Mortality of nymphs was greatest on Kansas Orange sorgo and least on Dwarf Yellow milo.

In a comparison of four varieties under field conditions, the bugs laid the largest number of eggs on Dwarf Yellow milo, the next largest on feterita and the smallest number on Blackhull kafir and Atlas sorgo. On all varieties, the bugs lived longer and laid more eggs on plants 45 days old and those in the heading stage than on plants 25 days old. There was no apparent correlation between resistance of plants and survival of adults. When reared in field cages, the adults were distinctly larger on Dwarf Yellow milo than on Atlas sorgo, those reared on feterita or Blackhull kafir being intermediate in size. Generally, bugs reared on headed plants were smaller than those reared on younger plants. Under field conditions, nymphs developed faster on Dwarf Yellow milo than on the other three varieties. The rate of development was not affected by the age of the plant. Nymphal mortality was lowest on Dwarf Yellow milo, highest on Atlas sorgo, and intermediate on feterita and Blackhull kafir.

It is believed that the condition or composition of the cell sap rather than any readily observable morphological character of the plant is responsible for the differences observed in the biology of the bug when feeding on plants of different varieties and ages. Whether these differences are due to absence, presence or quantities of certain food materials in the cell sap is not known.

Papers noticed by Title only.

Donovan (C. G.). **The Determination of DDT. A Review of analytical Methods for the Determination of DDT in the technical and pure Compounds and in various Insecticides, by total Chlorine Procedures.**—*Soap & sanit. Chem.* **22** no. 6 pp. 165, 167, 201, 4 refs. New York, N.Y., 1946.

Neal (P. A.) & von Oettingen (W. F.). **Toxicity of DDT. A Report on experimental Studies.** [A review of the literature on toxicity to man and other mammals.]—*Soap & sanit. Chem.* **22** no. 7 pp. 135, 137, 139, 141, 143, 23 refs. New York, N.Y., 1946.

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A detailed account of the Conference, together with the conclusions and resolutions arising from it.

A memorandum of the work of the Institute from 1935 to 1948 is given in Appendix I (pp. 14–19). The reports of the various Committees constitute Appendix II (pp. 20–26). Appendix III (pp. 27–112) consists of the proceedings of the scientific meetings, which are as follows :

Subjects	*Openers*
Recent Developments in Insecticides	R. A. E. Galley
Mode of Action of new Insecticides	V. B. Wigglesworth
Uses and Limitations of the new Insecticides in the Field	W. A. Ross
Recent Developments in Pest and Disease Control Machinery	H. G. H. Kearns G. H. Berkeley
Application of Insecticides from the Air ...	D. L. Gunn
Biological Control	A. B. Baird W. Cottier R. H. Le Pelley D. Miller
Estimation of Insect Populations in the Field	A. H. Strickland
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The Need for Plant Quarantine on a Continental Basis, with special Reference to Africa ...	G. F. Clay
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